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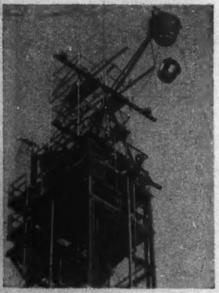

THE COVER: Lockheed Missiles and Space Division's static test stand in the Santa Cruz Mountains, Calif., was used for the Discoverer re-entry body drop tests. Photo shows re-entry body the instant following separation from the ejection cone. Axial instability is already apparent in this drop. Story on p. 233.

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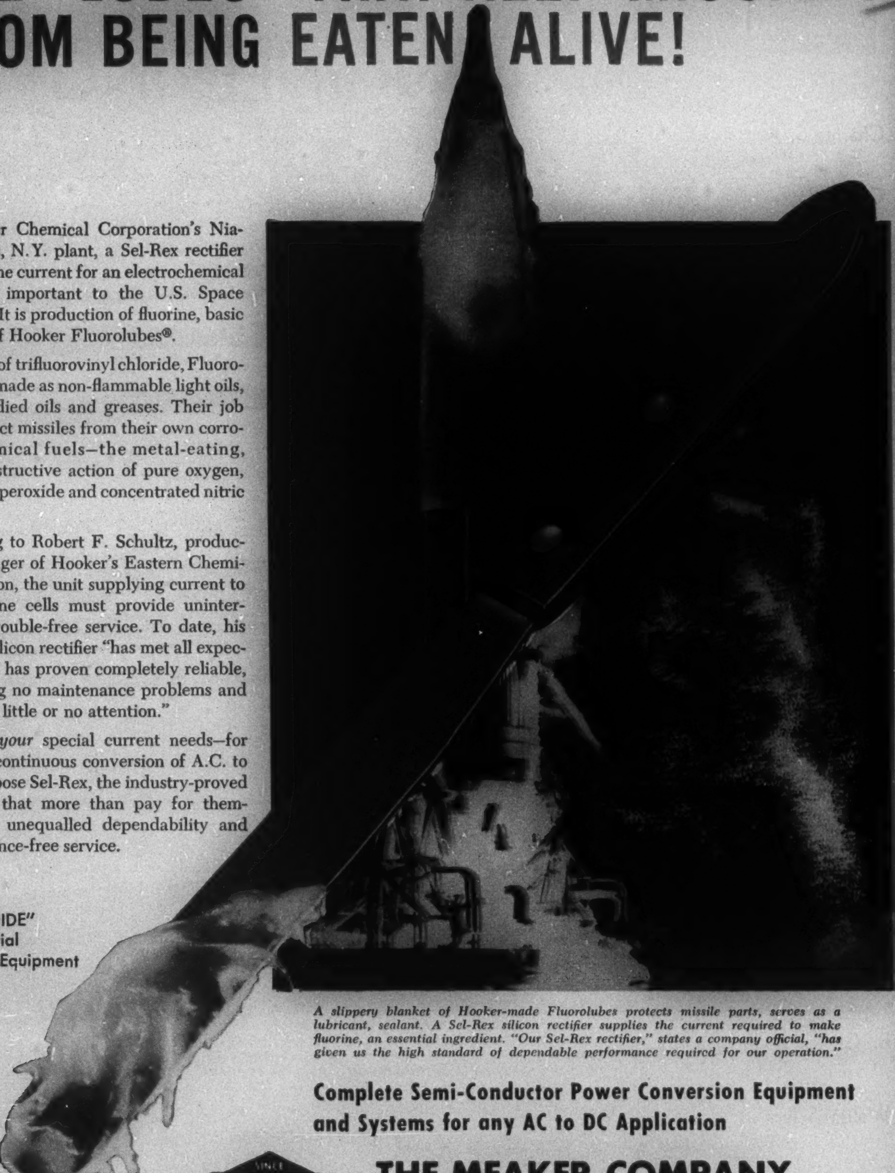

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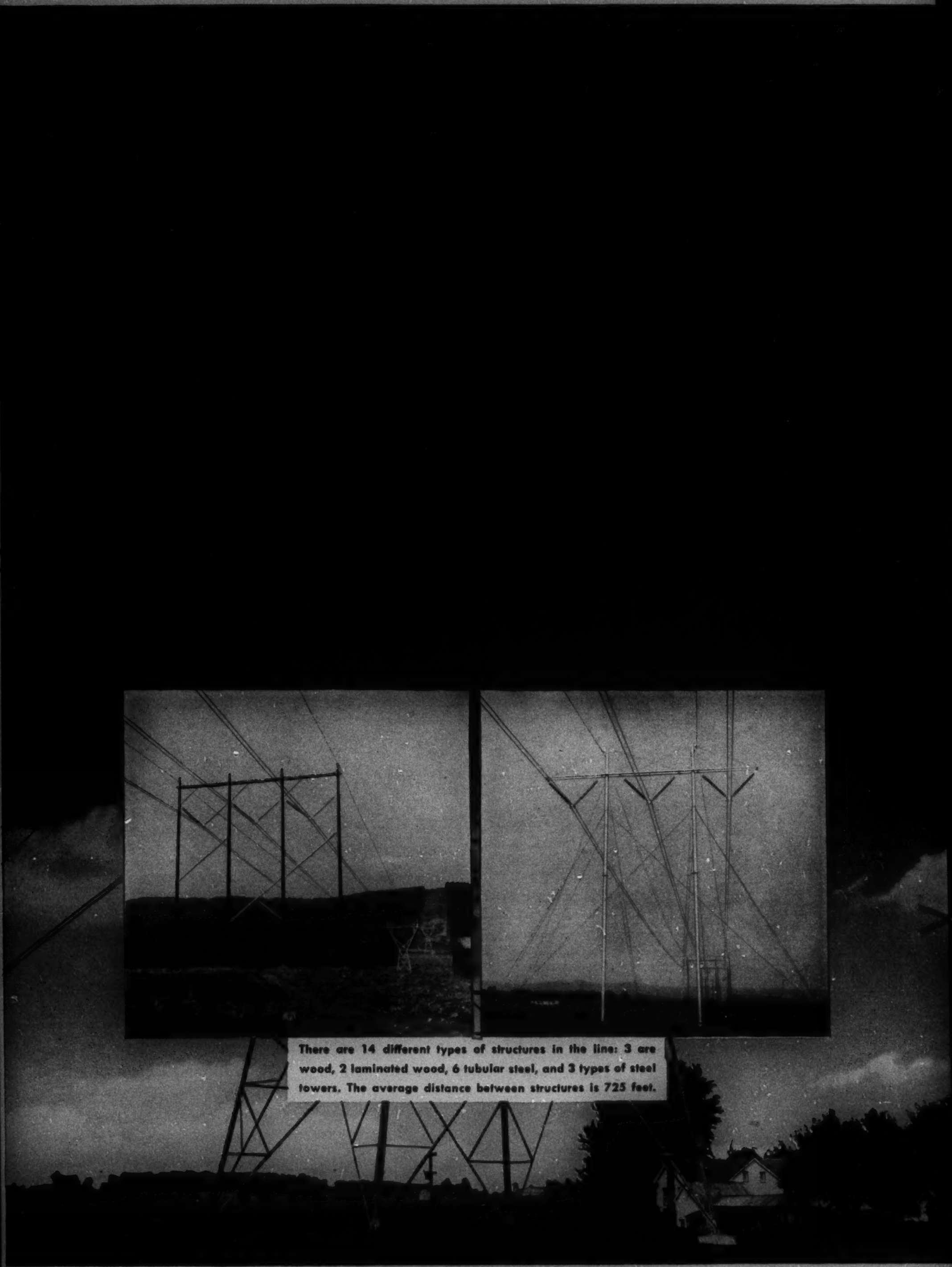

There are 14 different types of structures in the line: 3 are wood, 2 laminated wood, 6 tubular steel, and 3 types of steel towers. The average distance between structures is 725 feet.

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196

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The same engineering teams research, develop and use-test both EHV accessories and cable at Anaconda. The advantage is clear: no weak links in the system.

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New and Improved Products . . .

Trip-Cue Tape Recorder . . .

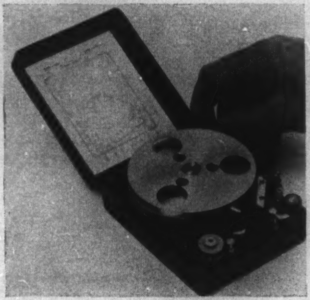
A new cartridge tape recorder that sounds a recorded signal to cue a second recorder to begin its playback will also permit multiple units to be automatically started in predetermined sequence for continuous playback of music, spot announcements, and other broadcast program material. The *RT-7A* is designed to produce two cue signals. One is placed on the cue track to signal the beginning of a tape program in the conventional manner. The other is recorded in a different frequency at the end of each recording. Sounding of the cue tone signal amounts to a command to the second recorder to begin playback after the first unit has run its tape. *Radio Corporation of America, 30 Rockefeller Plaza, New York 20, N.Y.*

New Potentiometer . . .

The component illustrated here is called a Stranducer and provides an entirely new type of rebalancing element for the ElectroniK *17* potentiometer. Superseding the conventional slidewire, the Stranducer permits infinite resolution with thermal stability, and possesses none of the slidewire's limitations. Essentially an electromechanical strain gauge, four looped-wire strands in an I-shaped frame form the variable resistance legs of the measured circuit with their resistance varying in proportion to the tension applied to them. As the pivot arm rocks back and forth, tension is increased on two of the wires and decreased on the others. The arm is linked mechanically through sector and strap reduction stages and drive cable to the balancing motor. *Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.*

Miniaturized Recorder . . .

A new 3-channel quality magnetic tape recorder measuring 2 by 4 by 5 inches and weighing 31 ounces including 7 ounces of tape, records dynamic data in the 100- to 5,000-cycle range for a minimum of 1 hour at 1⅞-inches-per-second tape speed. By virtue of its rugged small size, the *PS-303M* may be attached to an animal, inserted in a flight suit, or carried in a pocket. Accuracy of operation is unaffected by position or motion. Frequency response is flat with negligible flutter and wow and a signal-to-noise ratio better than 30 db. *Precision Instrument Co., 1011 Commercial St., San Carlos, Calif.*



Time-Event Sequencer . . .

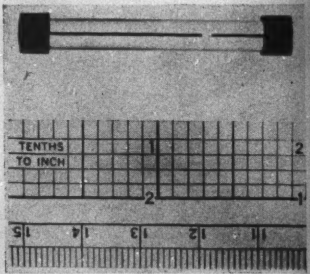
Up to eight separate events may be triggered from 100 milliseconds to 5 seconds apart with this latest time-event sequencer. Designated *TES-1*, the set provides relay switch operation to activate explosions, camera shutters, missile countdown procedures, and other events in a desired schedule. Intervals between each event are individually controlled to an accuracy of 5% of the dial setting. *Atlantic Research Corp., Alexandria, Va.*

Self-Contained Ultrasonic Cleaner . . .

Both the generator and cleaning tank of this 250-watt unit are housed in a 1-piece, polished, stainless steel, wrap-around cabinet. Controls are simple, with an on-off switch for continuous operation, an 0- to 15-minute automatic shut-off timer, and a tuning knob and meter. Capacity is 3 gallons. The cleaning compartment is 10 by 14 by 6 inches. *National Ultrasonic Corp., 111 Montgomery Ave., Irvington 11, N.J.*

Low-Drain Ampere-Hour Meter . . .

Extremely low power drain coupled with inherent lightness and small size makes this direct reading ampere-hour meter ideal as a battery life indicator for portable instruments such as radios, tape recorders, medical instruments, hearing aids, and radiation detectors. Essentially a microcoulometer, the device integrates current vs. time by electrochemical principles, using a mercury anode separated from a mercury cathode by a small electrolytic gap. Under an applied voltage, current flow transfers mercury quantitatively across the gap via balanced oxidation-reduction reactions. The operation is reversible. *Curtis Instruments, Inc., 45 Kisco Ave., Mount Kisco, N.Y.*



Parametric Amplifier-Converter . . .

Essentially the same design as the prototype model developed for satellite tracking and tropospheric scatter, this parametric amplifier-converter allows an operator to turn up volume of uhf signals without increasing static or other interference noises. In the Pioneer IV space probe, the amplifier enabled engineers to track the satellite for 215,000 miles, while similar tracking equipment without the amplifier lost the signal after 50,000 miles. Heart of the system is a diffused-junction silicon parametric diode. Since the device does not rely upon a metered flow of electrons for amplification, noises generated by conventional amplifier are eliminated, thereby resulting in an over-all receiver noise figure between 1.5 and 2.0 db. *International Telephone and Telegraph Corp., Clifton, N.J.*

(*Continued on page 30A*)

The Role of Electronics in National Survival

New weapons and weapon systems, differing radically in concept from our present weaponry, are urged as a means to gain a decisive lead over the USSR. To achieve this goal, research and exploratory development, especially in electronics, should be greatly expanded.

J. M. BRIDGES

MY TOPIC is one of vital interest to every American. It is also a subject that is generally not too well understood or appreciated. We hear and read a lot these days about national survival and the strength of our military forces. But most of it concerns such things as ballistic missiles, bomber aircraft, nuclear-powered submarines and satellites. We hear very little about the fact that the successful operation of all these weapons and systems critically depends upon electronic devices and systems of fantastic complexity and precision—devices and systems, that, in almost every case, have pushed electronic technology to the limits of the state of the art and sometimes beyond. This evening I want to tell you a little more about defense electronics and its significance in our endeavor to maintain a military strength sufficient to deter communist aggression.

Perhaps the best measure of electronics' importance in defense is the amount of national effort and defense dollars being spent in this area. The military departments are currently spending around $6 billion a year for electronics research, development, engineering and production—well over one-half the total national output of our great electronics industry and almost one-quarter of the total defense expenditure for all research, development, engineering, and production. Even more significant is the fact that approximately 40% of all military RDT&E funds is now going into the area of electronics. This tremendous military research and engineering effort employs around 80% of all the electronics scientists and engineers in this country.

CRUCIAL ROLE OF ELECTRONICS

OBVIOUSLY I DO NOT HAVE TIME to describe, or even list, the hundreds of different research and development programs that make up this vast national effort in electronics research and engineering—for instance, radar, infrared, computers, communications, acoustics, inertial guidance, and electronic components. Nor can I take time to explain the vital part played by electronics in each of our modern military weapons and systems. Instead, let me give just a few specific examples illustrating how critically the success of our military operations depends on electronics.

The development of the Nike-Zeus anti-ballistic missile defense system provides a good illustration. I suspect that most people realize that difficult technical problems are involved in producing a missile with the range, speed, maneuverability, and lethality it must have to intercept and destroy an ICBM warhead entering the atmosphere at perhaps twenty times the velocity of sound. But I doubt that many recognize that the complex and challenging problems of the missile's design are dwarfed by the technological difficulties involved in developing the radars and computers and the other electronic control devices required to make the Nike-Zeus effective.

The development of these major electronic systems, having the range capabilities, precision, and speed of operation that will enable the weapon system to detect the warhead, identify it among the decoys and rocket fragments, track it accurately, solve the fire-control problem, and direct the missile to an accurate interception—all in a very few short seconds—presents one of the most difficult research and engineering tasks ever undertaken in any technological area. The problem's magnitude and complexity can be seen from the fact that there are about one-half million active semiconductor devices in the electronic equipments making up a single Nike-Zeus defense center. It is a shocking realization when we compare this system with its fantastic number of active electronic components with the anti-aircraft fire-control systems of 15 years ago that, with only 500 vacuum tubes, were considered fearfully complex or even with the most modern surface-to-air anti-aircraft missile system, which has about 2,000 active electronic elements.

The intercontinental ballistic missile is also typical of the absolute reliance of modern weaponry on electronics. It is hard to imagine that a huge nuclear warhead can be projected across 8,000 miles of the earth's surface and hit a target well within 2 miles of the aiming point. This represents an angular accuracy approaching

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Essentially full text of a speech delivered at a joint meeting of the AIEE Philadelphia Section and Philadelphia Chapter, Armed Forces Communications and Electronics Association, The Franklin Institute, Philadelphia, Pa., Oct. 5, 1960.

J. M. Bridges is director, Office of Electronics, Office of the Director of Defense, Research and Engineering, Washington, D. C.

one hundredth of a degree and a range precision better than three thousandths of one per cent. This remarkable guidance by the electronic sensing and computing elements in the missile and at the launcher represents one of the most advanced and sophisticated applications of electronics technology; it took thousands of man years of scientific and engineering effort to develop.

In another weapons area, the B-70 manned bomber will contain the most advanced and complex array of electronic devices ever assembled in an aircraft. It has been estimated that the development and engineering of the bombing-navigation system alone will cost close to a quarter of a billion dollars and will require 8,000 to 10,000 man years of engineering. This is only one of the major electronic subsystems this advanced aircraft weapon system will need to perform its mission.

Probably the most exacting use of electronics in our whole defense program is in space developments. Certainly a space system depends more completely upon electronics than any other system in civilian or military use. Once a rocket carrying a satellite into orbit leaves the launching pad, information concerning the space vehicle's precise location or data acquired by its various sensing instruments (most of which are themselves complex electronic devices) can be obtained only by means of electronics.

In one of our current military space programs, the satellite carries equipment employing about 28,000 electronic parts—roughly equivalent to 100 home television receivers. To be operationally and economically feasible, this complicated equipment must operate satisfactorily in space, with no adjustment or maintenance, for long periods of time, perhaps a year or more. Can you imagine turning on 100 television sets and letting them run continuously for a year without having to adjust one set or replace a single defective part? Attaining reliability of electronic equipment that is essential for space applications poses a tremendous engineering problem. It will call for the development of electronic components and construction techniques that are far more reliable than those available today.

I hope these few examples make it fairly clear that electronics is the keystone of our military capability and, in most cases, the controlling technology.

Now I would like to mention the critical and urgent need for more rapidly advancing electronics technology across the board. This we must do to acquire the new electronic concepts, components, and techniques we need for the development of new weapons and space systems so advanced and so powerful that they will give us an undeniable—and, we hope, discouraging lead over the USSR.

Certainly I need not belabor the point that we must maintain such a position of military and technological superiority over the communist nations. From the time Mr. Khrushchev scuttled the summit meeting until recently, when he "declared war" on the United Nations, world events have clearly demonstrated that the only factors that might cause the communist powers to alter the frightening course of their drive toward world domination are the military strength and technological achievements of the United States and its allies.

RADICALLY NEW WEAPONS NEEDED

TODAY, THE BALANCE of military strength is in our favor. Both the President and the Secretary of Defense have said repeatedly that this nation has the most powerful military force the world has ever known—one that is not second best to the USSR or any other nation. I firmly believe that this is so, although I realize that in certain force postures the lead is marginal. Certainly if we are to stay ahead, we must continue to develop, produce, and deploy our weapons at an ever-increasing pace. But just staying ahead is not enough. In the critical years ahead, we must strive to create entirely new kinds of weapons based on new technology—weapons that will give the West a decisive military advantage. I am not speaking of weapons that merely evolve through refinement and gradual improvement of existing weapons but, rather, of radically new ones that can significantly change the balance of power in our favor. What sort of weapons these new ones will be, I cannot say; the atomic bomb was one; the ICBM was another.

Now why do I feel that future breakthroughs in weapons are so important? Very pertinent to this is the situation I see developing in the major strategic forces that constitute our deterrent and retaliatory power, which is so vital to our national survival. Our powerful strategic striking force of manned bombers, an extremely important part of our deterrent strength, is currently undergoing a rapid transition. It is being complemented by a family of ICBMs: The Atlas is now operational, the submarine-launched Polaris entered the Navy's operational forces last Fall, and the Titan will be added to our operational ICBM forces the middle of this year. In addition, the development of Minuteman, which has a shorter reaction time, greater reliability, and better performance than Atlas, is being pushed on an accelerated schedule.

With this rapid expansion of ICBM strength, both in the United States and the USSR, it seems obvious to me that, unless disarmament negotiations are successful, there will develop within a very few years a balance of deterrent strength between the communist and Western powers that will constitute a deadly and frightening stalemate of missile-borne destructive power. Each side will have a sufficient number of these missiles—dispersed, hidden, and protected by site hardening—for a potentially complete mutual destruction, even on a "strike second" basis. When such a weapon stalemate exists, it seems most unlikely that any nation would start an all-out thermonuclear war.

Although these supersaturated forces of destruction probably constitute an excellent deterrent to nuclear attack on this country—and, incidentally, provide a tremendous incentive for the negotiation of world disarmament—it does not appear that they will significantly deter the outbreak of limited wars. It is inconceivable that any nation would risk almost certain destruction of its civilization by employing such forces in limited military conflicts. This means that our tremendous investment in bombers and ICBMs will probably not keep the Soviets from continuing to nibble away, even using military force, at its long-range objective of world communism.

But, if we could definitely break this growing deterrent stalemate by acquiring some radically new weapons that would give us an overwhelming military advantage, we could not only deter all-out attack against us but might discourage continued aggression on a limited scale.

One thing that could break the balance of deterrent forces would be a truly effective system of defense against them—not one that would merely stimulate the opposition to build and deploy more missiles in an effort to re-establish the balance, but a defense system, including fall-out shelters, that could effectively protect our military, industrial, and population centers against a massive, all-out attack. Almost surely the nation that first achieves such a defense would have a tremendous military and political advantage, at least until methods of countering the defense were developed or until both sides had equally effective defenses.

This discussion of total defense against ballistic missiles illustrates my point concerning the potential importance of radically new weapons based on new technology. Obviously, this is only one area where such new weapons could exert a significant and, perhaps, decisive influence on the balance of power between East and West.

In tactical warfare radically new weapons could also be extremely valuable. As I said before, it is unlikely that our strategic thermonuclear forces will prevent aggressive acts of a limited nature on the part of the communists. It is essential, therefore, that the tactical forces of our Army, Navy, and Air Force be kept always at the highest possible level of efficiency. To this end, these forces should have ready to use the most advanced weapons that our scientists and engineers can provide.

Also in the area of command and control we urgently need new systems based on new concepts and new techniques. The requirements for reliabiltiy, capacity, and reaction times in command and control have advanced so rapidly with the growth of weapon capabilities that current computer and communications technology is not fully adequate to meet these system needs.

Our space programs also demand electronic components and techniques that we do not have at present. I am not just sure where space activities fit into the involved picture of competition for world supremacy. It is evident that satellites orbiting the earth have great potentialities for military use in communications, navigation, warning, and surveillance and various defense agencies are vigorously pursuing extensive programs in these areas. Probably other space ventures—putting "man in space," probing the moon or planets, or embarking on journeys beyond our own solar system—will profoundly affect our national prestige throughout the world. But the military implications of these ventures are not clear. Still we cannot afford to shut our eyes to these programs, nor to the revolting possibility that space—even outer space—may some day represent another dimension of man's battlefield. It is conceivable, for example, that space systems apart from the provision of early warning, might play an important role in establishing a fully effective defense against ballistic missiles such as I mentioned earlier. I just do not know how these things will develop—and I am not sure that anyone else knows.

To reiterate the point I have been making for the sake of emphasis: radically new weapons and systems can profoundly and, perhaps, decisively influence the balance of power between the communist and free worlds. Indeed it is entirely possible that a single fundamentally new weapon could be the determining factor in our civilization's survival in the coming decades. But any such weapon will almost certainly come out of new technology rather than refinements based on current weapon approaches. Accordingly, I consider it imperative that this nation shift an appreciable amount of its scientific and engineering resources from the task of developing generation after generation of weapons that only marginally increase our total strength to the task of research and technical development on which to base the new concepts and new techniques—and, possibly, the technological breakthroughs—that will make possible the development of decisive new weapons.

STRESS ON FUNDAMENTAL RESEARCH URGED

SINCE ELECTRONICS is now the most important single technology in weaponry, it is clear to me that this area should encompass the greatest expansion of this fundamental technological effort. I would expect to see in the broad area of electronics some of the great technological advances and breakthroughs that will impact significantly on our future military capability. I can not foresee what those breakthroughs will be, nor when they will occur, nor what effect they will have on the balance of world power. I can say, however, that throughout the country some very exciting things are going on in electronics research laboratories. Here are some of them: the generation and amplification of coherent light; computers that can learn and possibly "think"; microwave generators with outputs measured in megawatts of average power; thermionic power conversion; new methods of radio transmission wherein all system elements, including the antenna, are hundreds of feet below the earth's surface; and revolutionary concepts of solid-state and cryogenic electronics that may make it possible to house in the limited volume of a space vehicle a computer with the capability of the SAGE system. Some of the many new avenues of electronics research now opening up may hold the secret of a new force that could give us the desired unchallengeable lead over communism.

But, unless we put more national emphasis on research and exploratory development in electronics—and I want particularly to stress the need for additional emphasis on exploratory development—these and other promising technological advances in electronics will be far too long coming to fruition. It is not enough to expand our storehouse of knowledge through a broadened and accelerated program of fundamental research. We must carry out the applied research or exploratory development that is necessary to prove that it is feasible to apply this new knowledge to some new weapon concept. Otherwise, it may remain in the archives of scientific literature unused, perhaps forgotten by the developers of weapon systems, that is, unless it is found and used by the Soviet.

Now let me summarize the points I have attempted to bring out:

First, electronics is probably the most important and most critical area of technology affecting the development of all weapons and command and control systems.

Second, our future military strength and perhaps our national survival may depend upon weapons that are radically new and are based on advanced or new technology rather than weapons that are mainly "warmed-over" versions of weapons now in existence or well along in development.

Third, there is an urgent need to shift a substantial portion of our scientific and engineering resources from weapons development to research and particularly to exploratory development.

Finally, because electronics is so widely used in all military weapons and control systems, a major technological advance in this area may lead to a new weapons concept that will give this country a decisive military advantage.

In closing, I would like to say that I hope and pray—as I am sure most Americans do—that a way can be found at the conference table to solve the grave problems at the root of world tension. If the contest in weapons development continues between two nations so rich in industrial and scientific resources as the United States and the USSR, the result will be not only a persistent and increasing drain on our civilian economy, in both dollars and scientific manpower, but a steady increase in the danger of world-wide destruction.

Speaking in Syracuse 4 years ago, I expressed the hope that the challenge to all mankind to conquer space would be so great that his desire to fight among his own kind would disappear. I am afraid this was merely wishful thinking. In reality, the space programs of the United States and the USSR have had the effect of intensifying international rivalry rather than stimulating co-operative endeavors in scientific exploration.

We must keep hoping for, and working toward, a political or sociological kind of breakthrough that will lead to permanent peace among the great powers of the earth. At the same time, we must seek the technological breakthroughs that will enable us to keep our armed services strong enough to deter military aggression on all fronts until it is possible to bring about the disarmament of nations in a safe and acceptable manner.

The Quest for Thermonuclear Power

R. G. MILLS
MEMBER AIEE

The reasons for and the extent of the world-wide effort to harness light element fusion reactions for power production are described. A discussion of the physical problems to be surmounted and the different approaches being pursued in various world laboratories is presented. Future possibilities are considered.

FOR several years an appreciable number of people have been engaged in a world effort to solve an extremely difficult problem. Conceived and nurtured in secrecy, programs of at least four nations passed their infancy in isolation from one another. In 1956 communication was established between the British and American groups and in 1958 at the Second International Conference on the Peaceful Uses of Atomic Energy, secrecy restrictions were dropped. Now the task has reached its early childhood as a set of independent, healthy programs throughout the world engaged in a vigorous competition to be the first to achieve a sustained, controlled thermonuclear fusion reaction. If this can be achieved in the laboratory, it is expected that development of a practical commercial power source will follow.

The United States, USSR, England, and Germany have pioneered with large establishments, and significant programs are being undertaken in France, Sweden, Switzerland and Japan. No doubt laboratories in other lands will join in the search. Most of the work in the United States has been sponsored by the Atomic Energy Commission (AEC) under the code name, Project Sherwood. The early history of this project may be read in the book by the same name by Amasa Bishop.[1]

The size of the effort may be inferred from its budget. In recent years the AEC has been alloting between $20

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and \$30 million per annum. This is a sizable amount for a research project, amounting to about 1% of the AEC budget. The prime responsibility of the AEC is, of course, to provide the nation with an adequate and modern nuclear arsenal. After this responsibility, it should foster the development of nuclear equipment already suitable for commercial application; but if the controlled thermonuclear work is as important as its protagonists (as well as many unbiased observers) claim, 1% is not an excessive amount to spend on it even though commercial application still seems remote. Another measure of size is the number of scientific personnel devoting full-time attention to the problem. In the United States approximately 300 are involved in Project Sherwood. Throughout the world there are probably a thousand scientists and engineers, plus an equal number of supporting personnel, all studying this problem. Clearly the scientific community regards it as important. What are the reasons for this interest?

The fundamental or long-range motivation is the spectre of energy bankruptcy. The idea of the world simply running out of fuel seems rather fantastic. Is this a real problem or merely a dream of alarmists? Table I shows one estimate[2] of the history of the earth's energy consumption extrapolated to the middle of the next century in comparison with known and estimated energy resources. Although these data are somewhat controversial, the controversy centering mainly on the definition of the word "economic," the errors in these figures can be assumed quite large without invalidating the conclusion. Even if we assumed that the expensive and severe problem of radioactive waste disposal associated with fission plants can be solved, there is no alternative to a sharp decline in the standard of living beginning in perhaps 200 years if the deuterium energy source is not tapped. On the other hand, if deuterium fusion can be utilized to generate power, we have fuel for many millions of years.

This fact alone is not sufficient to justify a large-scale effort at the present time. The proper procedure would be to let science accumulate knowledge at its normal pace for the next century or so. Presumably we would then know a sufficient amount to design a fusion reactor with the confidence with which we can now design a steam engine. The reason for a vigorous attack on the problem now is the fact that the real cost of power is on its way up and will be significantly higher very soon. The world's electric power needs are doubling in a period variously estimated between 8 and 13 years. This exponential growth will not continue, but we can certainly expect the world's power consumption to reach a level of one Q (10^{18} Btu) per year. Compare this with our coal and oil reserves. Nuclear fission will remain an expensive process with poorly distributed fuel supply. Following the research stage of fusion studies, there will be a host of severe engineering problems to be solved. By the time this is accomplished, fusion could be the cheapest form of power generation benefiting from a world-wide distribution of fuel supply from the oceans. This might occur within 15 years.

Table I. World Energy[2]

Consumption	
Thru 1850	6—9 Q
1850—1950	4
1950—2000	15
2000—2050	100
Economic Reserves	
Coal	32 Q
Oil and Gas	6
Uranium and Thorium	600
Energy Resource in Oceans' Deuterium:	10^{10} Q

Table II. Comparison of Nuclear and Chemical Fusion

Chemical Fusion								
$2(H_2)$	+	O_2	$\longrightarrow$	H_2O	+	H_2O	+	2.4 ev
4p		(16p, 16n)		(10p, 8n)		(10p, 8n)		
Nuclear Fusion								
H^2	+	H^2	$\longrightarrow$	He^3	+	n	+	3.25 mev
(1p, 1n)		(1p, 1n)		(2p, 1n)				
H^2	+	H^2	$\longrightarrow$	H^3	+	p	+	4 mev
(1p, 1n)		(1p, 1n)		(1p, 2n)				

Another factor which should not be overlooked is that of national prestige. Everyone would like to say that it was his country which solved this protoproblem of civilization.

This article will attempt to explain the basic physical problems encountered in these studies and the reasons why they are difficult. The principal directions of research in various laboratories will be described, together with the present status of results achieved. Finally, a possible power plant of the future will be presented.

BASIC PHYSICAL PROBLEMS

TABLE II contrasts nuclear fusion with chemical fusion, the ordinary burning process. Note that a single fusion event in the chemical case yields a few electron volts of energy, whereas in the nuclear case the yield is a few million electron volts. The chemical process illustrated is the reaction of two molecules of hydrogen with one of oxygen to yield two molecules of water.

If one sorts through hydrogen atoms, one will occasionally find a special type. Like a 4-leaf clover in a clover field, about 1 atom in 6,000 of hydrogen has an extra particle in its nucleus. Instead of one lone proton, the proton is accompanied by a neutron. This double particle is called a deuteron, sometimes symbolized by the letter D, sometimes by H with a superscript 2, as done in Table II. If two deuterons are brought very close together, the four elementary particles can rearrange themselves in one or the other of the two processes diagrammed here to liberate a large amount of energy. If one has a supply of hydrogen from which to derive energy, it would appear to be far more profitable to sort out the deuterons and utilize nuclear burning than to use ordinary burning. Furthermore, for nuclear fuel we can use the hydrogen from water rather than from the isolated state.

The two types of processes compared here are not as similar as Table II tends to picture them. The number of protons and neutrons in the nucleus of the atoms

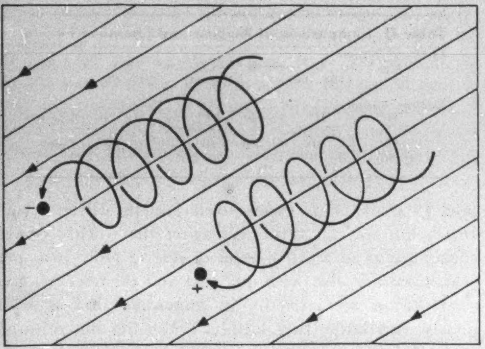

Fig. 1. Confinement by magnetic field.

have been cataloged for both cases, but in the chemical case they have nothing to do with the process. The nucleus of an atom is a tiny hard center. Around this exists a very deep and sticky layer of electrons occupying a million-million times the volume of the nucleus. It is only the outer layer of the electron cover that is involved in chemical actions. If we want to produce nuclear fusion, it is necessary to peel off the layer of electrons completely to get bare nuclei or otherwise the nuclei cannot get close enough together to react. This necessity of removing the electrons from the atoms completely is why the quest for thermonuclear power requires intensive study of the physics of fully ionized gases, sometimes called plasma physics. This form of gas is really a fourth state of matter following the vapor phase as the temperature is raised to very high levels. For hydrogen gas, the temperature would have to be 100,000 degrees before the gas became essentially completely ionized.

Although it is conceivable that one might maintain a gas of low density at 100,000 degrees within a physical container with sufficient cooling on the surface to prevent it from melting, this temperature is still far below the ignition point for lighting a nuclear fusion fire. Although the electrons have been separated from the nuclei and no longer interfere with the process, the nuclei still prevent the close approach necessary to bring about fusion because of the large electrostatic repulsion forces developed by their positive charges. In order to get the nuclei moving at a high enough velocity to get close enough together to fuse, it is necessary to heat them to very high temperatures. To get a barely detectable reaction intensity, one must approach 10 million degrees. To turn this smoulder into a blazing furnace, one must go to 100 million or better. This is the cause of the great difficulty encountered in research programs designed to study the properties of this fourth state of matter. A review of the physics of controlled fusion reactions may be found in an article by Post.[3] The fundamentals of fully ionized gases are presented in the book by Spitzer.[4]

Fig. 2. England's Zeta machine.

Before one can investigate the properties of a thing, one must get a sample. James Watt would have had severe difficulties developing the steam engine if he had not been able to get his water to boil! The scientists of the world are still trying to get some high-temperature plasma to study. The problem is twofold: (1) How do you heat the gas? and (2) During and after the heating, how do you confine and control it for a long enough time to study it?

No material can be used as a wall to contain a gas at these temperatures because so much of the material would evaporate into the gas that it would be promptly cooled below the temperatures of interest. Some nonmaterial containment method must be used. At this early stage there is only one method that we can flatly state will work to contain a reactor. To construct this form of thermonuclear machine we must begin in an isolated region and assemble so much fuel that its own mass will contain the reacting gases by gravitational attraction. Many of these reactors are in successful operation. They are called stars. Although we cannot do this on earth, a somewhat similar device is a hydrogen bomb which is contained for a very short time by inertial forces.

The only other forces available to us are electric and magnetic forces, old friends of electrical engineers. Virtually all methods of confinement under active study make use of a magnetic field as the confining tool. Since the reacting gas is completely ionized, each individual particle is charged. A moving charged particle in a magnetic field describes a helical path surrounding a given line of magnetic force. This is illustrated in Fig. 1. Each particle behaves as if it were rigidly attached to a line. It is free to move along the line easily, but it cannot move across the line. A gas of charged particles (a plasma) will move across the field very slowly by diffusion. The motion from one line to another is produced by a collision of two particles. This process is a very slow one, and the magnetic field is expected eventually to serve as a good confinement medium. At the present time, however, a quiescent plasma placidly diffusing across a magnetic field has not been observed. Strange instabilities and turbulent behavior take place.

Work continues in an attempt to understand the phenomena observed and to stabilize the situation.

POSSIBLE APPROACHES

THERE ARE A VERY LARGE NUMBER of magnetic field configurations that have been proposed, and many of these are under active investigation in dozens of laboratories. As examples, only three will be described—those which have received the greatest attention so far. These machines make use of the pinch effect, magnetic mirrors, and the stellarator principle.

The pinch effect was first pointed out in 1934.[5] If an electric current flows in a straight line, the magnetic field surrounding it exerts a force towards the axis on each charged particle carrying the current. Thus, the current channel tends to contract or pinch. Use of the pinch effect as the basic confinement mechanism is an extremely attractive idea because the current necessary to generate the confining magnetic field is carried by the ionized gas itself rather than by an expensive external coil system. However, a basic difficulty, first predicted theoretically and published in 1954,[6] is that the pinch is highly unstable, destroying itself in microseconds. When a small kink develops, the magnetic forces decrease on the outside, increase on the inside of the bend, forcing the kink to enlarge. A considerable amount of progress has been made in stabilizing the pinch by building in internal magnetic fields, but this restricts the possible compression of the discharge and limits the temperature. Vigorous work is continuing on these problems, however, and they may eventually be solved. England, USSR, and the United States are engaged in pinch studies on a large scale. The first large thermonuclear experiment to be built is the English Zeta apparatus shown in Fig. 2. In this machine the pinch current flows in a closed circle—thus the name toroidal pinch. The pinch acts as the secondary winding of a transformer. The main structure in the photograph is the transformer core which consists of 150 tons of steel. The primary is excited by a pulse of current derived from a condenser storage bank. The vacuum chamber is a torus of minor diameter 1 meter and major diameter 3 meters. Heating of the gas in the pinch comes from the ohmic losses from the conduction current itself and from adiabatic compressions when the pinch contracts. The English have achieved a temperature of a few million degrees in their apparatus. When photographs and reports of Zeta became available, the Russians built a copy in the amazingly short time of 6 months and named it Alpha. Their results have confirmed the British experience. The American pinch work originated at Los Alamos. A variety of smaller machines have yielded similar results both at Los Alamos and at the Lawrence Radiation Laboratory.

If one attempts to confine a plasma by means of a solenoidal field as illustrated in Fig. 3, a problem of end losses appears. There is no opposition to particle motion along the lines of force. Something must be done to prevent immediate escape of the gas from the ends. If regions of higher field strength are placed at each end, the magnetic lines will be bent as shown in the lower part of the figure. These regions of increased field strength are known as mirrors and serve to reflect most particles back towards the midplane. A few, those with velocities almost parallel to the axis, escape. This is a disadvantage of the mirror type of machine. On the other hand, this is the only type of machine so far studied which has not yet shown any evidence of plasma instabilities. The Lawrence Radiation Laboratory at Livermore, Calif., has been investigating these machines for many years. Heating in a mirror can be done by adiabatic compression, or by the injection of material already at high energy. The latter approach is being studied at Oak Ridge where the DCX experiment shown in Fig. 4 is being conducted to study injection of ions of energy up to 600 kev (kilo-electron

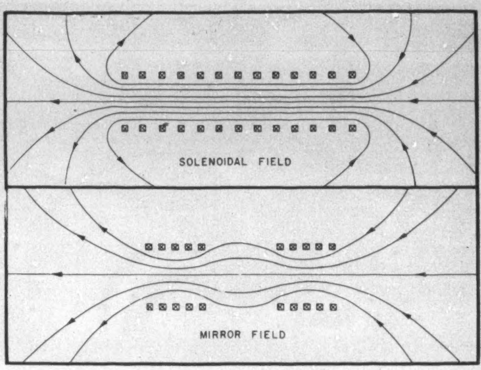

Fig. 3. Two magnetic configurations.

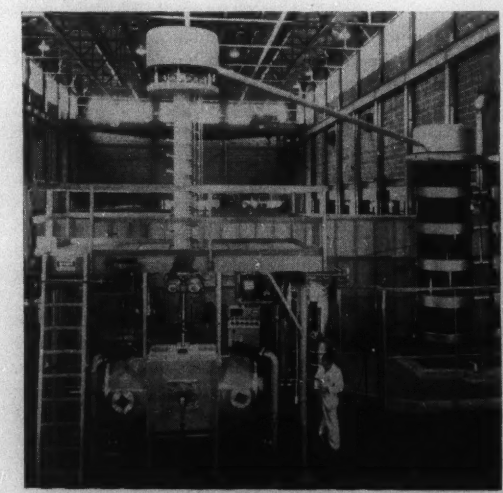

Fig. 4. The DCX machine.

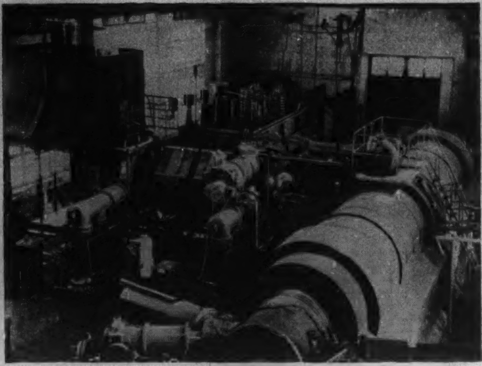

Fig. 5. The OGRA machine.

volts) into a mirror machine. In this machine the large power supply provides the potential difference to accelerate molecular ions. These molecular ions are dissociated within the machine by passing through a carbon arc and the resulting atomic ions are trapped within the machine.

The Russians are conducting another energetic ion injection experiment with the OGRA apparatus shown in Fig. 5. This is also a mirror geometry and is believed to be the largest fusion research device now in operation.

The stellarator approach[7] combats the end losses by bending the solenoid into a closed configuration. Since the plasma now forms a closed loop it can be made the secondary of a transformer and heated by passing a current through it in a manner similar to the toroidal pinch device, but at currents far below those needed to pinch a plasma. This type of heating is called ohmic heating. Other more complicated methods of adding energy to the gas by electrical methods known as magnetic pumping and cyclotron resonance heating are also under investigation.[8] This work has been carried out at Princeton University where the model *C* stellarator is now being assembled. When this apparatus is put into operation this year, it will be the most elaborate plasma experiment in existence. Temperatures in smaller stellarators have reached a few million degrees, but the ohmic heating process produces instabilities which are not yet understood and which limit confinement to less than a millisecond. Stellarators have been investigated principally at Princeton, but are also being planned in Germany and the USSR.

Inevitably the questions arise: Who has the best idea? Who is ahead? Who is going to win the race? It is too early to guess at the answers to these questions. As time goes on you can judge for yourself by reading papers and getting the answers to these questions: What is the time of confinement of the plasma? What is its temperature? How large is the production of thermonuclear neutrons? Answers to these questions are not always clearcut. For example, as long as confinement time remains short, one is observing a transient phenomenon. A plasma is a mixture of two fluids—the electron fluid and the ion fluid. Under transient conditions these two fluids can have different temperatures. It is the ion temperature that is important for producing thermonuclear reactions, but it is the electrons that are most frequently directly heated. Temperature measurement at these levels is not precise and under short transient conditions the fluids may not have achieved Maxwellian distributions, in which case the temperature is not well defined. Neutron production has been detected in many laboratories, but have they been true thermonuclear neutrons? This is a moot point and should be discussed briefly.

What is the difference between a thermonuclear neutron and a so-called "false" neutron? There is no difference between the neutrons themselves or even between the reactions which produced them. The differnce is in the type of collision that led to the reaction. A neutron is thermonuclear if it is produced by a fusion of two deuterons that were both present in a gas and collided with their respective thermal velocities. A neutron is produced by a nonthermonuclear process (i.e., it is a "false" neutron) if one deuteron has been accelerated to a high velocity by some nonthermal mechanism (e.g., an induced electric field) whereupon it collided with a static target (e.g., a deuteron bound to the wall of the apparatus or an unaccelerated deuteron in the gas). At the present time it is not a simple matter to determine whether or not the neutrons observed include an appreciable number of true thermonuclear neutrons. In the writer's opinion, no experiment has yet been performed which does. The doubt arises because the temperatures achieved so far have remained low. When ion temperatures actually are produced well above 10 million degrees, so many neutrons will be produced that the thermonuclear process is the only one that will be able to explain them. As soon as plasma temperatures, as measured by neutron production, reach 20 or so million degrees for 50 or more milliseconds, then will be the time to ask, "Who is ahead?"

POWER PRODUCTION

LET US TAKE a long look into the future and speculate about a successful power plant producing fusion power. As an example I will choose a stellarator plant because it is the type with which I am most familiar. This does not imply that I think the stellarator will be the only or even the first successful reactor. The plant is presented schematically in Fig. 6. Working from the inside out, the vacuum tube contains the reacting fuel. In this case a 50-50 mixture of deuterium and tritium is chosen because it burns faster and yields more energy than pure deuterium. In this case the fuel consumed is deuterium and lithium, but eventual development to pure deuterium-fueled reactors is expected. The density of the gas would correspond to a pressure of about 0.00001 atmosphere at room temperature—a good vacuum from an industrial point of view—

but at an operating temperature of 150 million degrees K would exert a pressure of 100 pounds per square inch —a very high-pressure vacuum indeed! This pressure would be contained by a magnet of field strength of the order of 100,000 gauss produced by coils of a special configuration to reduce internal stresses. Cooling of the coil might be done by conventional deionized water or possibly by nucleate boiling or cryogenics.

Between the vacuum tube and the confining field coils is located a lithium-bearing blanket which serves to absorb the generated neutrons, converting their kinetic energy into heat and regenerating from lithium the tritium needed to operate the reactor. This also serves as a radiation shield for protection of the magnet and other surroundings. The blanket is cooled by steam generation, and the steam is used in a conventional steam-turbine-driven generating station.

There has been some talk about direct conversion of the released energy into electricity. In principle, particularly in the case of a pure deuterium reactor, this can be done for a fraction of the released energy by cycling the confining field strength. However, much of the energy released (and in the case of the deuterium-tritium reactor, most of the energy) is in the form of neutrons. This energy can be recovered only by utilizing a neutron absorbing blanket and a heat cycle.

Along the two legs are two devices that have not been described in this article, although working apparatus has already been put into experimental operation in the laboratory: a magnetic pumping unit for igniting the fire[8] and a divertor[9] for maintaining the purity of the reacting gas.

The useful output of such a plant would be in the neighborhood of 2 million kw, an inconveniently large block of power. However, in the decade or two that will pass before such a unit is available, there will no doubt be areas where it would be useful. The size of the minimum useful power output is really a question of economics and it would be idle to try to estimate the investment cost of such an installation now. Most power transforming units become more economic as their size increases and this is very strongly true of a stellarator. Consequently one can predict with fair confidence that if thermonuclear power plants become possible they will be very attractive economically if built in a large enough package. Time will tell if this minimum package will be small enough to be attractive. In addition to the probable economic advantage, such a plant would have no radioactive wastes. The ash is helium, a useful product itself.

All long-range predictions have the common property of being dead-wrong, but it is difficult to resist the temptation to speculate about the future. Those who are interested in a well-reasoned study of our species from an ecological and demographic standpoint should read the excellent book by Harrison Brown.[10] More detailed cataloging of data on population and energy trends may be found in the report by Putnam,[2] cited earlier, from which one can draw one's own conclusions. It is interesting that neither of these books has considered the possibility of fusion power. If fusion power is successful, the future would appear quite different from their conclusions. It is conceivable that 500 years from now the earth's population could have been reduced to a level of 20 million people by a series of nuclear holocausts. Such a population, carefully husbanded to cope with a damaged genetic heritage, could live an abundant life on solar power. On the other hand, it is also conceivable that the harnessing of fusion power will provide an opulent standard of living for a population of 20 billion. Certainly if the human race exercises its full growth potential (and barring new, unexpected basic discoveries), the electrical engineers of the future will have to deliver fusion power.

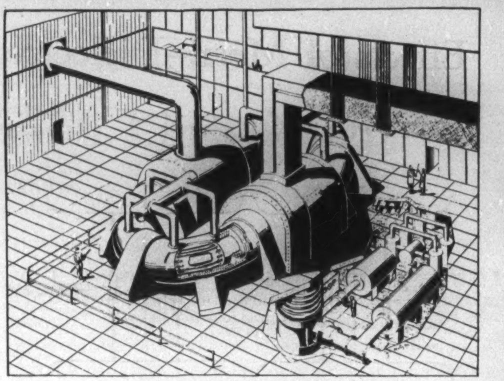

Fig. 6. Future power plant.

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PLAN NOW TO ATTEND

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Effects of Metal–Dielectric Junctions on Breakdown

M. J. KOFOID
MEMBER AIEE

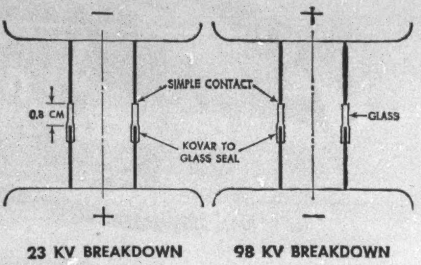

Fig. 1. Illustration of improvement in d-c vacuum breakdown voltage obtainable by changing polarity to prevent junction discharge phenomena.

TO OBTAIN the highest breakdown strength over insulators in vacuum, the method of joining the dielectric to the negative electrode is of high importance.

In a recent paper[1] it was disclosed that discharge phenomena can occur at the negative metal–dielectric junction of insulators in vacuum and that these phenomena can be effective in lowering the breakdown voltage. With a metal electrode in simple contact with a dielectric, electrons and radiation are released at the edge of the junction. The positive metal–dielectric junction plays no important role.

With short insulators in air at 10^{-4} to 10^{-5} millimeters of mercury pressure, elimination of junction discharge phenomena was found to increase the breakdown voltage by a greater amount than any other factor to which lowering of breakdown in vacuum has been normally attributed. With the arrangement shown in Fig. 1, junction discharge phenomena existed to a degree which led to appreciable lowering of the breakdown voltage only when the metal at the simple mechanical-contact junction was negative. As indicated, tests showed an increase by a factor of about four in the d-c breakdown voltage when the negative junction discharge phenomena were prevented.

When high-voltage insulators are operated at atmospheric pressure, the negative metal–dielectric junction is known to be a source of radiation and, as a result, of free electrons. However, this radiation is strongly absorbed close to the junction. The electrons, because of their very short mean free paths, cannot gain high energies by acceleration in the electric field, recombine quickly, and any effect they have in lowering the d-c breakdown strength of the gas must be very local.

In contrast, in vacuum the electrons set free at or in the immediate vicinity of the negative junction can travel distances comparable to the length of the insulator before making a collision. The result is that released electrons can cause the production of X rays, negative ions, and further electrons. These actions are believed to lead to the lowering of the breakdown voltage.

Two practical types of solution to the problem can be readily employed with roughly comparable improvements. As with the Kovar–glass seal junction of Fig. 1, the edge of the junction can be moved to a point of low electric gradients by the advantageous placement of dielectric. Also, the electrode geometry can be made such as to reduce the electric field intensities in the gaps at the edge of the junction below a critical value.

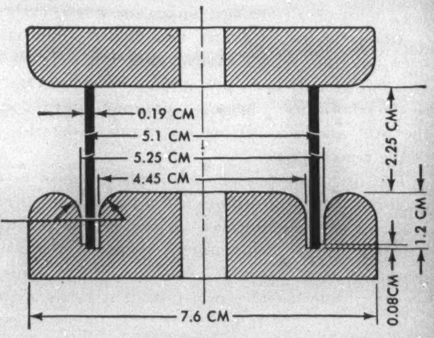

Fig. 2. Glass cylinder between electrodes designed to permit high breakdown strength in vacuum. Lower electrode is negative.

One way to reduce the electric gradients through electrode geometry is by locating the edge of the junction at the bottom of a groove in the negative electrode, in the manner indicated in Fig. 2. The effectiveness of this design, using a Pyrex glass cylinder as insulation, was shown by test results; the breakdown voltage was 28 kv with the grooved electrode positive, 90 kv with it negative. With the same electrode separation but with no groove in either electrode, the breakdown voltage was 25 kv.

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Effect of Bundle Conductor Field on EHV Transmission Line Design

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MEMBER AIEE

A description is presented of some control shield designs used commercially at 345 and 460 kv, along with results of laboratory tests indicating the trend of the art for multiconductor systems above 460 kv. Improvements in electrical performance and reduced capital costs are shown possible with towers designed for new suspension hardware developed for multiple-conductor bundles.

LABORATORY tests on prototype suspension insulator assemblies show that the electrostatic field surrounding multiple-conductor bundles can be exploited to eliminate control shields. Yoking arrangements were developed to couple the conductors as high with respect to the insulators as permitted by mechanical stability considerations. Tests were made on various assemblies to equivalent system voltages ranging from 650 to 865 kv. No upper limit on transmission voltages was established for conventional suspension insulators without control shields.

Elimination of control shields and abbreviation of insulator assembly length permit significant reductions in phase spacing, tower dimensions, and right-of-way widths. Capital cost savings from more compact transverse dimensions are accompanied by improved electrical performance associated with reduced phase spacing. Lower surge impedance improves lightning performance, and transmission stability limits are increased.

Realization of maximum benefits is dependent upon co-ordination of yoke plate geometry with maximum ice-load unbalance on the subconductors. Field data is needed to establish design criteria in icing districts.

PURPOSES OF CONTROL SHIELDS

Below 300 kv—Arcing Protection. The use of control shields and arcing devices dates back to the very early days of the electric power industry when arcing protection of conductors and insulators was necessary. A secondary benefit was thought to be increased flashover voltages through more linear voltage grading of the insulator string.

Higher speed relay and breaker operations, the use of overhead ground wires, the use of armor rods for conductor protection, and improvements in the thermal shock resistance of insulators have largely eliminated the need for arcing horn protection in recent American practice. Also, it has been learned that because preflashover ionization effects a marked redistribution of insulator voltages, control devices are largely ineffective for increasing flashover levels.

Above 300 kv—Electrostatic Stress Grading. With the advent of system voltages above 300 kv, the possibility of excessive corona on insulators and hardware at operating voltage has required the use of control shields. These shields surround the lower insulators and suspension hardware with a crude Faraday cage, thus reducing the electrostatic stress within and near the shielding structure. While it has been recognized that design of clamps, yoke plates, and attachment fittings could be modified to eliminate troublesome sharp corners and projections, the need for reduced insulator corona has generally demanded the use of control shields.

It has usually been more economical to use standard

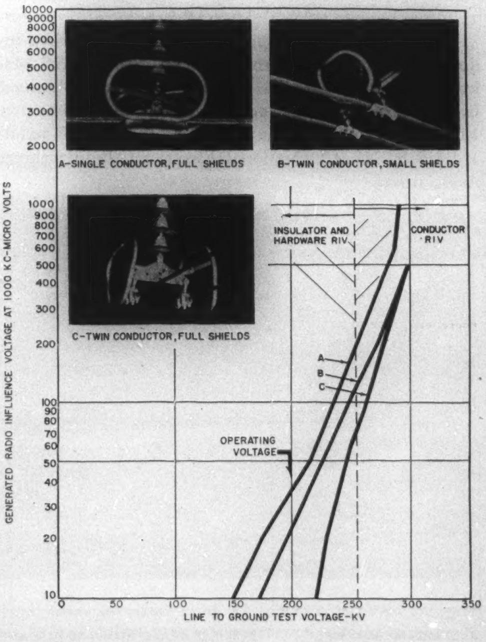

Fig 1. 345-kv suspension assembly radio influence voltage.

Abridged text of paper 61-171, "Effect of Bundle-Conductor Field Influence on EHV Transmission Line Design," recommended by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., Jan. 29-Feb. 3, 1961. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1961.

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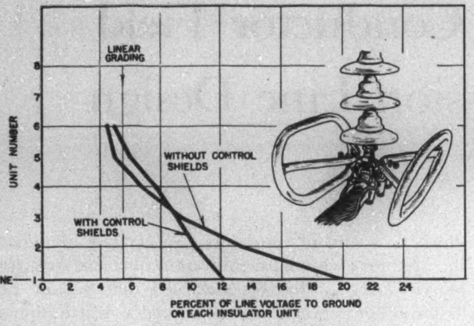


Fig. 2. 18-unit string voltage distribution at 345-kv phase voltage.

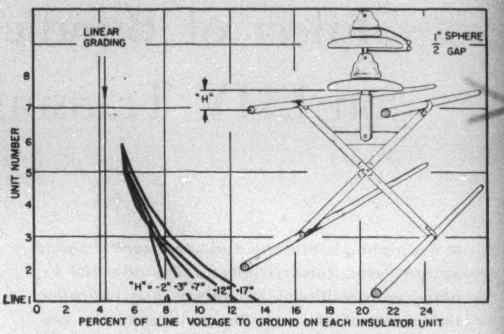


Fig. 3. 24-unit string voltage distribution at 460-kv phase voltage.

hardware and to modify the design of the insulator-grading control shields to include the secondary functions of hardware shielding and arc protection. Thus, commercial control shields have served multiple purposes, although the only functions which could not have been solved by other means have been those of insulator radio influence voltage (RIV) suppression and reduction of insulator corrosion resulting from corona-induced ozone concentrations. With recent improvements in the ability of suspension insulators to withstand corrosion attack, the suppression of insulator RIV has remained as the sole requirement for control shields.

345-KV PRACTICE

FIG. 1 SHOWS the RIV performance obtained from indoor laboratory tests of three different commercial 345-kv suspension assemblies. These curves were obtained by measuring the RIV generated by the specimen at 1,000 kc with a direct-coupled meter in a circuit standardized by NEMA (National Electrical Manufacturers Association).

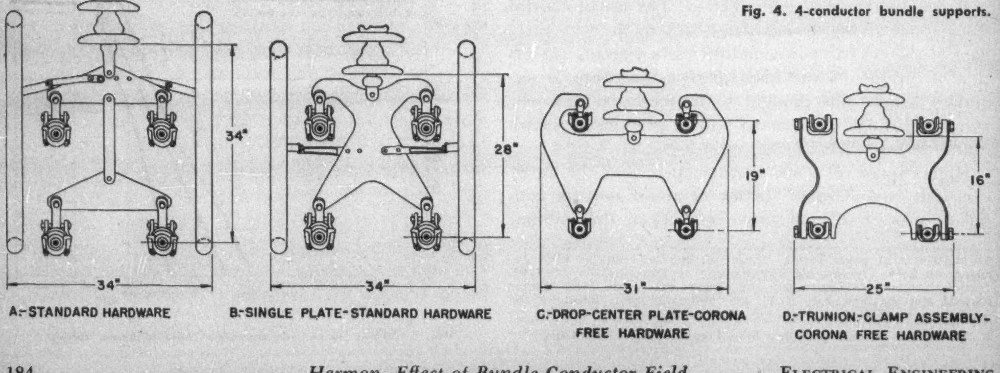
The low RIV levels at operating voltage of the fully shielded single-conductor assembly *A* are from minor corona discharges on the insulators. The RIV at operating voltages on the semishielded twin-conductor assembly *B* is from corona on the insulators and the exposed clamps. There was no measurable RIV on the fully shielded twin-conductor assembly *C*. From the intermediate performance of the partially shielded assembly it can be concluded that control shields are not so vital for twin-conductor systems. They may be abbreviated, or even eliminated, depending on the evaluation of permissible RIV levels.

The improved performance obtained with twin-conductors, even with incomplete hardware and insulator shielding, results from reduced electrostatic stress around the lower insulator units. Separation of the conductor into two or more elements reduces the field gradient over a sizable region surrounding the conductors, so that the conductors themselves perform part of the function of control shields.

The effect of control shields on insulator voltage distribution of a single-conductor assembly is shown in Fig. 2. The voltage on the critical line-end unit is reduced from 20% of the total to 12%, while that of the second unit drops from 14% to 10%.

460-KV PRACTICE

ALTHOUGH THERE IS no existing full-scale 460-kv trans-



A-STANDARD HARDWARE

B-SINGLE PLATE-STANDARD HARDWARE

C-DROP-CENTER PLATE-CORONA FREE HARDWARE

D-TRUNION-CLAMP ASSEMBLY-CORONA FREE HARDWARE

Fig. 4. 4-conductor bundle supports.

mission line on the American continents, an operational test line is now under evaluation on one United States system. This line uses a variety of hardware and control shield arrangements, which are primarily adaptations of commercial systems used at 345 kv. However, the shields are physically larger to suppress RIV at the higher operating voltage.

TEST PROJECTS ABOVE 460 KV

IT HAS GENERALLY BEEN FOUND that economic and engineering factors will require the use of 3- or 4-conductor bundles at voltages above the 460- to 500-kv level. In some test projects above 500 kv where the conductors are the primary object of study, insulator and hardware RIV performance is held to a low background level by large space-consuming shields. It should not be assumed that practical control shields must also be large and unwieldy.

The laboratory work reported herein was performed to determine the shielding required on commercial multiple-conductor systems, and the special hardware was developed to exploit the findings of these tests.

LABORATORY TESTS

EARLIER TESTS had indicated that hardware components could be made inherently corona free, but the problem remained of suppressing insulator corona without using control shields. The improved insulator RIV performance noted with twin-conductor systems suggested that further improvement should be possible with 3- and 4-conductor bundles. The action of the conductors as capacitive flux sources to the insulator string indicated that the conductors should be coupled as close to the insulators as possible. The tests summarized in Fig. 3 were made to determine the effect of coupling length on insulator stress grading.

Four 1.108-inch-diameter ACSR conductors were arranged in a square configuration on 18-inch centers and suspended from a 24-unit string of 5¾- by 10-inch insulators. The supporting hardware consisted only of an elementary cross-member to maintain proper conductor spacing, with a variable length connector to the insulators.

The voltage distribution at 265 kv (the leg voltage of a 460-kv system) was measured with a ½-inch sphere gap consecutively attached to the cap and pin of each insulator. The gap was preadjusted to flash over at the voltage expected across the insulator to which it was attached when the total line-to-ground voltage was 265 kv. Thus, the voltage distribution was obtained by consecutive determinations of the gap setting required to flash over at 460-kv system voltage.

A series of these tests was performed with different coupling links between the insulator string and bundle conductor assembly. The results in Fig. 3 show the grading improvement obtained with short coupling. A comparison with the curves of Fig. 2 shows that linear insulator grading can be approached to a degree heretofore unattained on single-conductor systems.

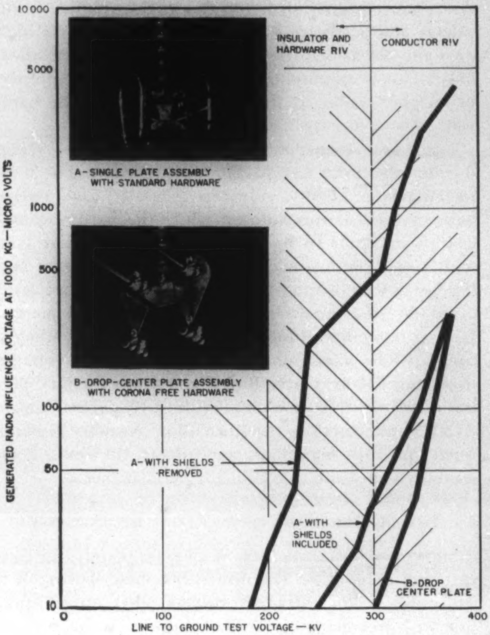


Fig. 5. 500- to 650-kv suspension assembly radio influence voltage

To apply this effect to practical suspension assemblies, laboratory corona and RIV tests were performed on several prototype supports. Two of these assemblies are shown in Figs. 4-B and 4-C. Fig. 4-A is an assembly of standard components included for dimensional comparison. Fig. 4-D represents an experimental assembly with even shorter coupling than those tested.

The RIV performance of assembly 4-B with and without control shields is shown in Fig. 5. Twenty-four insu-

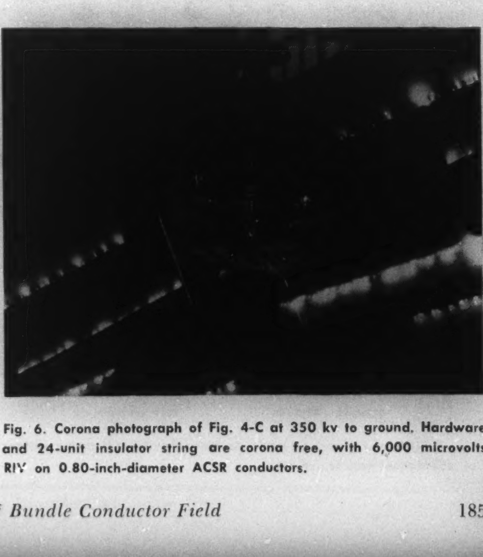


Fig. 6. Corona photograph of Fig. 4-C at 350 kv to ground. Hardware and 24-unit insulator string are corona free, with 6,000 microvolts RIV on 0.80-inch-diameter ACSR conductors.

lators were used. Omission of the shields resulted in insulator and hardware RIV that may be excessively high on some 460-kv systems. When shields were included, only a small amount of insulator corona was present below the conductor threshold voltage, and the hardware was corona free.

Fig. 6 is a corona photograph of assembly 4-C taken during laboratory tests at 350 kv to ground. The 0.80-inch-diameter ACSR conductors generated 6,000 microvolts of RIV at this voltage, while the hardware and 24-unit insulator string were corona free. Similar tests with larger conductors showed that the insulators and hardware were corona free to the maximum test level of 400 kv to ground, and have an unexplored margin beyond this point. Thus, this assembly without shields, from an RIV standpoint, is suitable for system voltages to at least 650 kv. Curve B of Fig. 5 shows the RIV performance of this assembly with 1.108-inch-diameter ACSR conductors. As the suspension assembly remains quiet up to the maximum test voltage, the curve is essentially a measure of conductor performance.

TOWER AND RIGHT-OF-WAY COST REDUCTIONS

Short-coupled insulator assemblies permit line construction economies. The minimum phase spacing of a flat-configuration extra-high-voltage (ehv) transmission line with free-swinging tangent supports is determined at the tower. Tower dimensions which maintain adequate arcing distance from energized hardware to structure under wind loads, increase phase spacing beyond other requirements. Thus, insulator-assembly length and width reductions permit closer phase spacings, with corresponding reduction in tower dimensions and right-of-way widths.

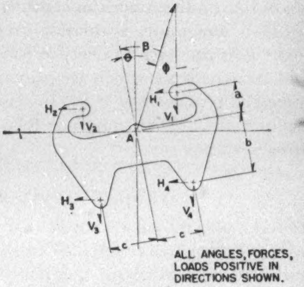


Fig. 8. Generalized load conditions of assembly 4-C.

$$\text{TAN}\ \phi = \frac{H_1 + H_2 + H_3 + H_4}{V_1 + V_2 + V_3 + V_4} \qquad (1)$$

$$\text{TAN}\ \theta = \frac{c[V_1 - V_2 - V_3 + V_4] - a[H_1 + H_2] + b[H_3 + H_4]}{c[H_1 - H_2 - H_3 + H_4] + a[V_1 + V_2] - b[V_3 + V_4]} \qquad (2)$$

$$\beta = \phi + \theta \qquad (3)$$

For constant span-length and mid-span ground clearance, cross-arms may be lowered through the use of more compact insulator assemblies. Lower ground wires result from closer phase spacing, and strength requirements throughout the structure are reduced.

Fig. 7 shows an example of the size reductions possible on a 460-kv H-frame. The figures shown are based on the assumption that a 10-foot striking distance is required at 45-degree insulator swing. Twenty-six 5¾- by 10-inch insulators per string are assumed, and other tower dimensions are intended to be representative of 460-kv practice. While the right-of-way width depends on individual practices, the reduction permitted with the structure shown would remain constant at 9 feet. This is three times the phase spacing reduction, and is based on the assumption that right-of-way width is dependent on maximum outward swing of the conductors.

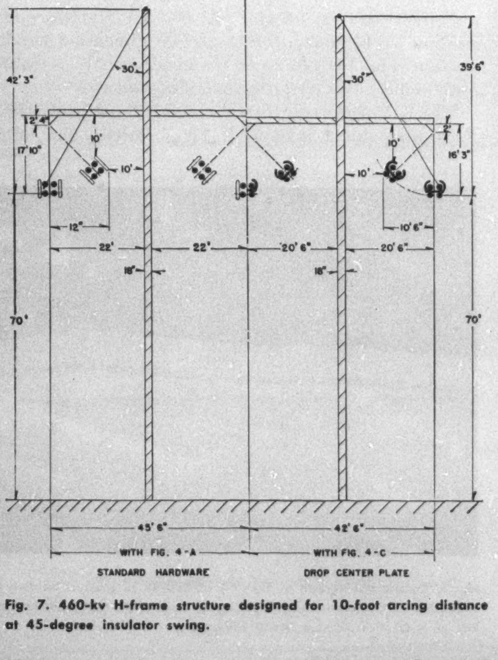


Fig. 7. 460-kv H-frame structure designed for 10-foot arcing distance at 45-degree insulator swing.

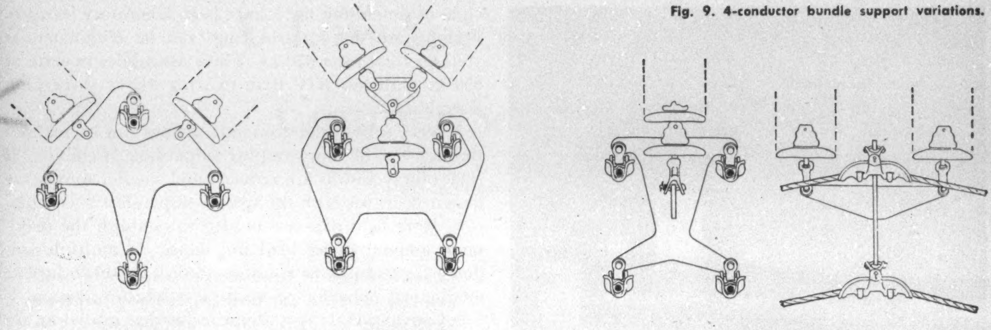
ELECTRICAL PERFORMANCE

The electrical performance of an ehv line is improved with mid-span phase spacing reductions. The lower inductance and increased capacitance associated with closer phase spacing improve electrical stability, thus increasing the transmission capability. Reduced surge impedance of conductors and ground wires improves lightning performance.

The increase of electrostatic stress around the conductors is one detrimental effect of closer phase spacing. However, the stress is raised only 1 or 2% for the spacing reductions under consideration, and the increase in conductor corona effects probably would be inconsequential when compared to the advantages of closer phase spacing.

MECHANICAL STABILITY

Mechanical stability problems may be divided into static and transient classifications. Difficulties with static



A- V-STRING

B-Y-STRING

C-DUAL STRING

Fig. 9. 4-conductor bundle support variations.

stability on a free-swinging structure arise principally from unequal ice and wind loads on the subconductors. No problem exists in light-loading districts, where the vertical loads are always equal and differences in wind loads are insignificant. When horizontal and vertical loads are equal, the insulator assembly swings as a unit with no relative motion between insulator string and yoke assembly.

In districts where icing is encountered, determination of static stability requires assumptions regarding maximum unbalance of ice buildup on the subconductors. With vertical or horizontal load unbalance, the yoke assembly will pivot about the point of insulator attachment. The generalized loading conditions of assembly Fig. 4-C are shown in Fig. 8. Summing moments about the attachment point *A*, and summing both horizontal and vertical forces yields the static equilibrium equations 1 and 2. Equation 3 shows the relative rotation of the yoke plate with respect to the insulator string. Graphical solutions can also be used for solutions of specific conditions.

Clearance limits between the insulator string and yoke plate limit the relative rotation angle β to $23\frac{1}{2}$ degrees on this assembly. Solutions of equations 1, 2, and 3 for various loading assumptions show that angle β would generally exceed $23\frac{1}{2}$ degrees when combinations of heavy, medium, and light ice and wind loads are assumed to exist over full span-lengths of the four conductors.

It is concluded that use of this system in a heavy or medium loading district requires careful co-ordination of plate design with maximum unbalance assumptions. Additional data on unusual icing conditions of multiple-conductor systems would be very helpful in predicting mechanical performance.

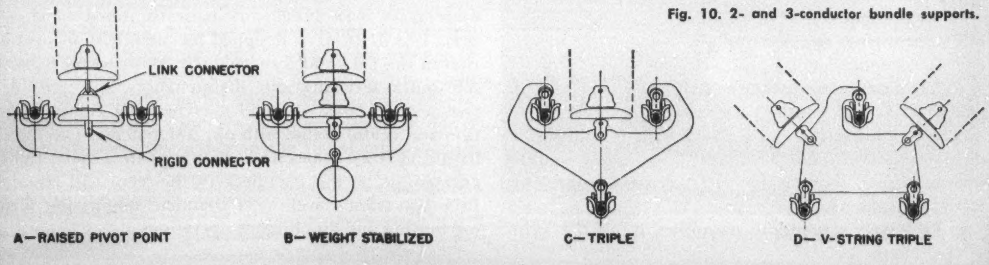
Transient motions resulting from ice unloading, short circuits, gusty winds, and possible aerodynamic instability again depend on a wide range of conditions. Any theoretical analysis would necessarily be based on so many simplifications and questionable assumptions that its validity would be doubtful. It is probable that the only satisfactory design criteria must come from field data.

OTHER SHORT-COUPLED VARIATIONS

THERE ARE MANY COMBINATIONS of insulator, hardware, and conductor arrangements which develop the mechanical and electrical advantages accruing from short coupling. Figs. 9 and 10 show some of the possible variations for supporting 2-, 3-, and 4-conductor bundles. The short-coupled system is inherently more adaptable to triple and quadruple-conductor bundles than to twin-conductor systems, because of the mechanical stability problem. However, Figs. 10-A and 10-B show two possible means of stabilizing a horizontal twin-conductor system.

The swinging restraint of V-insulator strings offers further possibilities for phase spacing reductions and tower and right-of-way economies. In addition, mechanical stability considerations may favor V-strings where severe unbalanced ice conditions are encountered.

The assembly shown in Fig. 9-C is especially adapted



A-RAISED PIVOT POINT

B-WEIGHT STABILIZED

C-TRIPLE

D- V-STRING TRIPLE

Fig. 10. 2- and 3-conductor bundle supports.

Fig. 11. Photograph of assembly 9-C mounted in outdoor laboratory.

to icing districts. Use of two parallel insulator strings may be required to sustain heavy ice loads on four conductors. Longitudinal separation of the suspension clamps and yoke plate from the insulators appreciably increases the rotational clearances, so that static and transient stability are improved. As the yoke assembly is enclosed within the bundle, clamp accessibility is improved.

Fig. 11 shows this assembly mounted for corona tests in the outdoor laboratory with 34 5¾- by 10-inch insulators per string. A small discharge near the pin of one of the line units was the only visible discharge at 500 kv to ground, which is equivalent to 865-kv system voltage.

This performance, with the other tests reported herein, indicates that control shields can be eliminated at transmission voltages higher than any presently contemplated. Hardware designed for this purpose also permit tower and right-of-way economies and improved transmission-line electrical performance.

CONCLUSIONS

1. Higher speed relay and breaker operations, the use of overhead ground wires, the use of armor rods for conductor protection, and improvements in the thermal shock resistance of insulators, have largely eliminated the need for arcing horn protection at all voltage levels.

2. Improved suspension insulator resistance against ozone-accelerated hardware corrosion has reduced the importance of this control ring function for ehv.

3. Twin-conductor 345-kv suspension assemblies without control rings may be sufficiently corona-free for operation on some systems.

4. Twin-conductor 460-kv suspension assemblies will probably require control rings.

5. The conductors, particularly with 3- and 4-conductor bundles, should be coupled as high as possible with respect to the insulators to improve the insulator RIV characteristics.

6. Prototype suspension assemblies using the principle of conclusion no. 5 have been laboratory tested to demonstrate that control rings can be eliminated at voltages to at least 650 kv. These assemblies operate at 650 kv with less RIV than existing 345-kv suspension assemblies.

7. Very substantial economic savings can be realized through use of short-coupled suspension assemblies, if right-of-way widths are reduced and smaller towers are designed for use with the special suspension assemblies.

8. More field data are needed to establish the maximum amount of ice load unbalance on multiple-conductor systems. Data are also needed on the transient mechanical behavior of multiple-conductor systems.

9. Conventional cap-and-pin suspension insulators are suitable for transmission voltages beyond any presently contemplated.

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Mobile Communications

A highly mobile, jeep-mounted, single-sideband communication system, the *MRC-83*, designed and manufactured by Collins Radio Company for U.S. Marine Corps field use, provides reliable short- and long-range communication over 28,000 automatically tuned r-f channels. The *MRC-83* is designed for simplicity of operation in the field and is of modular construction to permit quick servicing and maintenance. The *MRC-83* system offers voice, cw, and teletypewriter communication and is also usable with old AM systems. The high-frequency 1-kw transceiver, mounted in a water-tight encasement on the rear deck of the jeep, will remain fully operational even after complete submersion during fording and amphibious operations.

A Low-Speed Thyratron Counter-Scaler Unit

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Counter-scaler units are used in many areas of electrical engineering and the physical sciences where measurement and control of pulse-type signals are required. Component circuits and operation are described of a scaler unit that can achieve any desired scaling factor by the use of feedback in cascaded binary circuits.

IN many fields of measurement, it is necessary to time recurring events accurately and to record high-speed phenomena. A counter-scaler unit is used in those applications where the counting of a large number of pulse signals must be done by relatively slow mechanical recording devices. It is particularly useful in nuclear physics and cosmic ray measurements where the frequency of received pulses is not uniform in time, and where the pulses are of such high frequency that mechanical counting devices are not feasible. By scaling, that is, reducing the apparent recurrent rate, to a speed that is compatible with mechanical recorders, the number of received pulses may be recorded on a reduced scale for later evaluation. Scaling is that process by which the number of input pulse-type signals is divided or scaled down by a predetermined number, called the "scaling factor." Scaling units have been employed extensively in areas of nuclear physics for pulse counting, in multiplex communications systems for timing purposes, and in various other areas of recording and control of high-speed phenomena.

A low-speed counting and scaling unit has been designed employing thyratron tubes as the switching elements. The operation of this unit will demonstrate the use of feedback in cascaded binary counting circuits to achieve a scaling factor of any desired integer. The counter-scaler unit that was built to demonstrate the use of feedback in cascaded binary circuits is shown in Fig. 1.

DESIGN CRITERIA

THERE IS MUCH INTEREST in the design of counter-scaler units because of their varied requirements of scaling factors, frequency limits, heat dissipation, and reliability, and the useful life of circuit components. Electronic engineers and physicists are constantly faced with these problems, either in the actual measurement and recording of data, or in the design of appropriate equipment for these operations. The scaling factor is chosen on the basis of the relative frequency of data to be recorded and the speed of response of the recorder, and is determined in part by the choice of a number system for the recorded data. The decade number system (powers of 10) used in day-to-day activities is easily understood, and a scaling factor of 10 or 100 is commonly used. Other scaling factors are necessary in some applications, so that scale-of-5, scale-of-25, and other circuits must be designed.

Other problems in scaling operations may be eliminated by using special components and circuits. Transistors are useful in circuit requiring low heat dissipation, but stability and reliability are very difficult to obtain in transistorized units without extreme care in the design of the circuits using them. Matched parts are usually necessary in these circuits. Because the transistor is temperature-sensitive, the use of this component in scaler units is undesirable in some applications.

The thyratron, a gas-filled tube, depends upon gas ionization for its operation, and its heat dissipation is very small. It has a long life, and because it has a very positive switching action when used in scaling operations, the thyratron is very reliable as a scaler component.

Characteristics of a Thyratron. A thyratron is a hot-cathode gas-filled tube containing, in addition to the plate and cathode, a special grid structure. In this tube, the grid almost completely surrounds the cathode and

Fig. 1. Counter-scaler demonstrator.

Essentially full text of the first prize student paper in the 1959-60 competition of AIEE District 13. Recommended for publication by the AIEE Educational Publications Committee.

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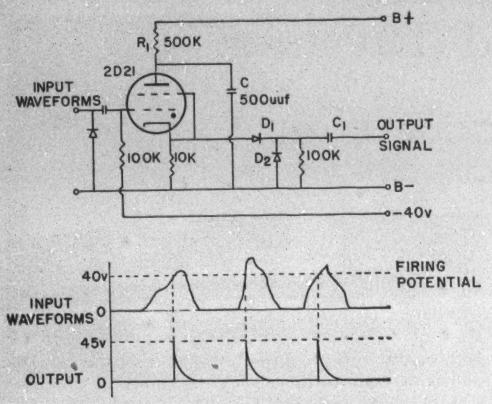

Fig. 2. Input trigger circuit and waveforms.

plate structures. The purpose of the grid is to determine the conditions under which the gas will ionize. Because the grid almost completely shields the cathode from the plate, it is possible to nullify a large potential on the plate by a relatively small negative potential on the grid. In this way the grid is able to control the plate voltage at which the gas will ionize and the tube start its conduction. However, as soon as conduction starts and the ion plasma is established, the grid no longer has *any* control over the plate current. The plate current then is determined by the applied voltage and the load impedance. This result is the consequence of the formation of an ion sheath around the grid structure during conduction.

In order to stop conduction of a thyratron, the plate voltage must be brought near zero, since the grid has no control of plate current during conduction. Conversely, if the grid of the tube is biased quite heavily, 30 volts or so, the tube may be turned on only by bringing the grid voltage near zero while the plate voltage is positive. This is easily accomplished by applying to the grid positive pulses of the proper magnitude. When the correct potentials are applied to the electrodes of a thyratron to start its conduction, some finite time elapses between the application of the potentials and the breakdown of the gas. This is the ionization time of the tube, and is usually small (1 microsecond or less). In the same way, when the plate voltage is reduced to zero to stop conduction, the thyratron requires a deionization (turn off) time. The deionization time is the minimum length of time required after plate current ceases for the positive ions of the grid sheath to diffuse away and be neutralized to an extent that the grid can control the tube when the plate is again made positive. The deionization time is determined by several factors, including the magnitude of current interrupted, the shape and size of electrodes, and the gas pressure in the tube. The deionization (turn off) time is usually much longer that the ionization (turn on) time for a given tube.

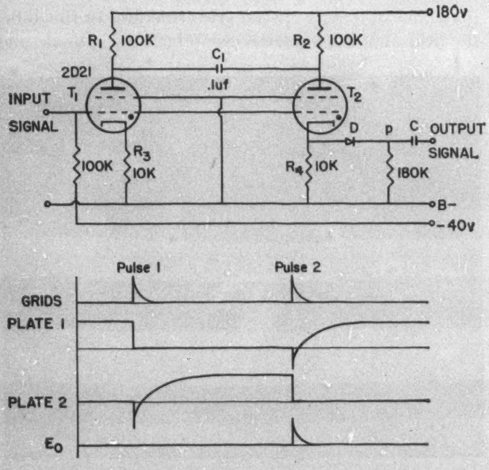

Fig. 3. Binary circuit and voltage waveforms for one complete cycle.

The characteristics of the thyratron grid and plate voltages in controlling plate current make the thyratron tube a very good 2-state device, which is necessary in counting and scaling units employing the binary system of on-off operation.

THEORY OF THE SCALER UNIT

THE SCALER which was designed consists of three sections, hereafter designated as the "input trigger," "binary," and "delay" sections. The operation of each of these sections is described below.

Input Trigger Section. The input trigger section is designed to accept as inputs various voltage waveshapes, and to yield as an output a uniform waveshape. This action is shown in Fig. 2. This circuit, employing a thyratron tube, is useful as a trigger-pulse source when the input signal that is being counted is not of uniform waveshape. The thyratron will conduct whenever its grid is brought positive enough to allow conduction, regardless of the waveshape of the grid signal. Since the thyratron is characterized by an avalanche type of action when it comes into conduction, it is well suited for forming voltage spikes for initiating binary action.

The action of the trigger circuit occurs in this manner. When the grid is driven positive enough above its 40-volt bias to allow conduction, the normally off tube will fire and send out one positive pulse through the output diode-capacitor network, D_1-C_1. After the input pulse has receded, and with the tube now in conduction, capacitor C discharges, allowing a sufficient voltage drop across R_1 to reduce the plate voltage below the value necessary to hold the tube in conduction. When this value of voltage is reached, conduction ceases, and the circuit will accept another input waveform to repeat the process. Thus, a uniform output signal is obtained for various input waveforms.

Binary Section. The criterion for a simple electronic scaler is that it have two stable states between which it may be switched. This makes possible a circuit that is designed to give one output pulse for every two input pulses. A unit of this design is usually referred to as a "binary" or "scale-of-2" circuit. Such a circuit employing thyratron tubes is shown in Fig. 3. Assume that the initial state of the binary is such that tube T_1 is off and tube T_2 is conducting. Now if a positive pulse is fed into the grids, T_1 will fire. The plate voltage of this tube will drop, and due to the differentiating effect of C_1, a negative spike will appear at the plate of T_2 which will cut off its plate current. The action of the circuit is now complete until a second positive pulse is applied at the grids. This will fire T_2 and a similar action as explained previously will cut off the plate current in T_1.

When T_2 fires upon the application of the second pulse, the drop across R_4 sends a positive pulse through the diode D and capacitor C. This output pulse occurs for every two input pulses, or whenever T_2 fires. This circuit, then, is a scale-of-2 divider, yielding one output for every two input pulses. The output of a single binary stage such as this circuit may be used as the input to another succeeding stage, to yield an ultimate division by any power of two, by a requisite number of stages.

The binary section of the demonstrator built in this project is made up of a series of cascaded binary stages; i.e., the output of one binary serves as the input to the next in the series. Since each individual stage divides the number of incoming pulses by 2 (scale-of-2), two stages in series will divide by 2^2 (scale-of-4), and it follows that n stages in series will divide by 2^n. The operation of binaries in series is shown in Fig. 4. This system is limited to division by numbers that are powers of 2.

Feedback in Cascaded Binaries. If it is desired to divide by a number other than a power of 2, circuits that include feedback may be employed to yield division by any chosen integer. Examples are scale-of-5, scale-of-10, and others. These scalers use the binary system with forced resetting at some specified count. This resetting, or "advance of count" as it is called, restores the circuit to some predetermined condition, and is effected by feeding back the output of some stage to one of the preceding stages. An individual binary stage cannot distinguish between pulses that are fed back and those due to additional input pulses. Through the use of feedback in this manner, one or more of the binary stages may be switched even though no additional pulses were applied to the input of the system. This reduces the number of input pulses necessary to yield an output, and therefore reduces the number by which the system would normally divide. The difference between the new divisor (with feedback) and the normal divisor (without feedback) is known as the advance of count.

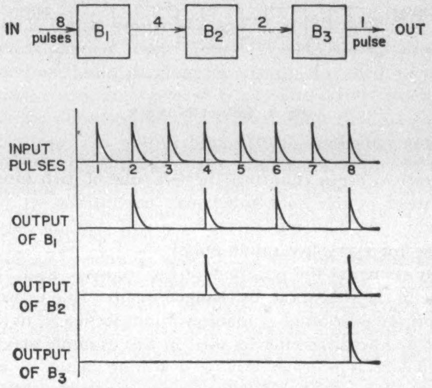

Fig. 4. Operation of binaries in series.

To examine the effect of feedback in cascaded binary stages, consider the system illustrated in Fig. 5, where B_1, B_2, etc., are individual binary stages, and feedback lines between stages are shown. Each binary is made up of two thyratron tubes and their associated components as explained previously. Let the tube on the right side of each binary be conducting (state 1) and the left tube be nonconducting (state 0). If one pulse is applied at the input, B_1 will change to state 1; i.e., from right tube conducting and left tube off, to left tube conducting, right tube off. Now when a second pulse is sent in, B_1 will return to state 0 and send one pulse out to B_2, which will change the state of B_2 from 0 to 1. If pulses continue to arrive at the input, ordinary binary action takes place until the eighth pulse. At this time, T_6 is turned on (B_3 returns to state 0), and the positive pulse from the output of B_3 resets B_1 and B_2 through the feedback lines. Now after the thirteenth pulse (5 more pulses), the system will be in the same state as it was after the eighth pulse. Then for every five pulses applied at the input, the system will undergo a complete cycle and one output pulse will be obtained; i.e., the system is dividing by 5, and is a scale-of-5 circuit.

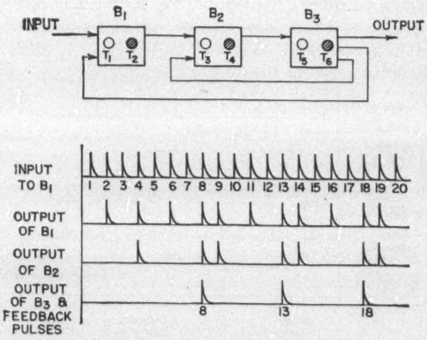

Fig. 5. Feedback in cascaded binary stages.

To avoid having to feed in the additional pulses to complete the first cycle of operation, a scheme for unsymmetrical initial setting may be used. When the unit

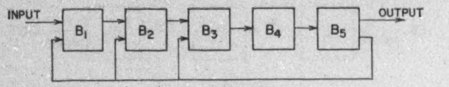
INPUT
B1
B2
B3
B4
B5
OUTPUT

Fig. 6. Scale-of-25 circuit.

is reset to begin counting, the left tube of each binary (instead of the right tube) may be initially set into conduction. This initial condition will yield an output pulse for every five input pulses.

By changing the positions of the feedback leads, the scale of the system can be changed to any value between 1 and the maximum available without feedback, in this case, 8. The three binaries used in this example may be employed as a scaler having a scaling factor of any integer between 1 and 8, by proper feedback arrangement. Feedback from the output stage to B_1 advances the count by 2^0, to B_2 advances the count by 2^1, and to B_3 by 2^2. Thus, in the circuit of Fig. 5, feedback from the output stage to B_1 and B_2 advances the normal count by 2^0 and 2^1 $(1 + 2 = 3)$, and the circuit divides by $8 - 3 = 5$.

As a further example of the theory of feedback in binaries, let us look at the factors necessary to design a scale-of-25 circuit. First, a standard binary circuit having a scaling factor of 32 (closest to, but greater than 25) will be chosen. Second, in order to convert this scale-of-32 divider to a scale-of-25 circuit, the count will need to be advanced by $(32 - 25) = 7$. Since feedback from the output stage of the system to B_1 advances the count by $2^0 = 1$, to B_2 by $2^1 = 2$, etc., the total advance in count with feedback to the first three positions will be $(1 + 2 + 4 = 7)$, the required number. The circuit arrangement that is necessary to obtain a scale-of-25 scaling unit is shown in Fig. 6.

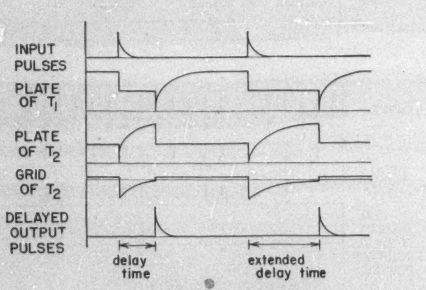
180v
100K
C1
100K
2D21
T1
.2uf
T2
R1
450K
INPUT
SIGNAL
C2
OUTPUT
SIGNAL
100K
10K
22K
100K
100K
B-
-40v
INPUT
PULSES
PLATE
OF T1
PLATE
OF T2
GRID
OF T2
DELAYED
OUTPUT
PULSES
delay
time
extended
delay time

Fig. 7. Delayed-output circuit.

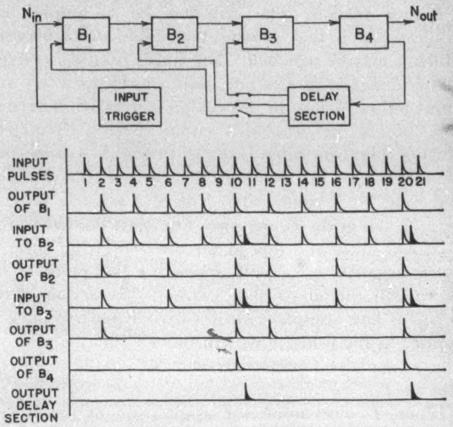
Nin
B1
B2
B3
B4
Nout
INPUT
TRIGGER
DELAY
SECTION
INPUT
PULSES
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
OUTPUT
OF B1
INPUT
TO B2
OUTPUT
OF B2
INPUT
TO B3
OUTPUT
OF B3
OUTPUT
OF B4
OUTPUT
DELAY
SECTION

Fig. 8. Block diagram and timing sequence of the demonstrator as a decade counter (delayed feedback pulses blacked in).

The advance of count that will be needed in a particular application of the scaler may be obtained by feedback from the output of the last binary to various points in the circuit. However, this is not a rigid rule, since other schemes work well for certain values. It is usually less complicated to feed back from a common point, since some circuits, such as the ones described using thyratron tubes, will require some amount of delay between input pulses and the pulses that are fed back. This delay time is necessary to allow the operation of a single binary to be completed between the application of successive pulses.

Delay Section. A binary circuit will function properly if the pulses applied at its input are not too close together in time. The minimum time that must occur between successive pulses for accurate counting is referred to as the "resolving time." Due to the deionization time of the gas in the tubes, a thyratron circuit usually has a longer resolving time than a corresponding vacuum-tube circuit. One of the main problems encountered in the design of scaler circuits employing thyratron tubes is the required delay time between the application of pulses, to allow for the deionization times. If the time elapsing between the input pulse to a particular stage and the feedback pulse to that stage is less than the resolving time, the feedback will have no effect on its operation, because the grid of the tube will not be able to control plate current as it should.

Circuits may be designed that will obtain a resolving time of about 10 microseconds or less. This length of time will limit the frequency of signals that may be counted by a given scaler unit employing thyratron tubes. The time interval between input pulses must be longer than the resolving time if feedback is employed from the output to the first stage. Feedback to other than the first stage is not so stringent, although some delay is still required in these cases. Feedback from a common point is desirable, because only one delay network will be necessary to provide the required time interval for all stages.

The monostable multivibrator shown in Fig. 7 can be readily used as a pulse delay device since it has an inherent delay. This circuit is designed such that tube T_2 is normally conducting and T_1 is off. If a positive pulse is impressed at the input, T_1 will fire and T_2 will cut off. When T_2 cuts off, its plate voltage rises rapidly along the charge curve of capacitor C_1 and, as a result, its grid voltage rises rapidly along that same curve, since the grid is coupled to the plate through R_1. When this action occurs, T_2 fires, T_1 is cut off, and a positive pulse appears at the output terminals. The time for the action described above is the delay-time of the circuit, and is variable within limits if R_1 and C_1 are variable (Fig. 7).

The Complete Scaler Circuit. The block diagram and associated timing diagram for a complete system used as a scaler circuit are shown in Fig. 8. This unit is arranged with the delay section as a separate unit that accepts a pulse from the output binary stage, and after delay, feeds this pulse back to any number of points in the preceding binary stages to effect the required advance of count. In the demonstrator that was built as a part of this article, feedback to the first three stages is achieved by closing appropriate switches in the feedback lines at the output of the delay section. The timing diagram is shown for feedback to the second and third stages only, and the result is a scale-of-10, or decade, counter.

A Semiautomatic Method for Resistor Testing

W. P. BURKE

F. J. SCOTT

This article describes a semiautomatic resistor test method and explains how this method implements the gathering of data necessary for reliability predictions. Also explained are the constructional details of the test system, including the various units and associated hardware.

ACCUMULATED resistor test data provide broad information relative to performance under closely controlled laboratory conditions. This information is projected to indicate what can be expected during field usage. Thus, a predictability program based on information supplied by automatic test equipment takes on added significance.

A reliability theorem states that parallel results can be obtained through testing a small number of sample items over a long period of time or through testing a great number of samples over a short period of time. Although the short-time test is capable of producing more immediate results, its time-saving advantage is somewhat offset by the burden of gathering and processing the greater magnitude of data if only manual methods are employed. Thus, automatic techniques for performing these tasks are desirable.

This article describes a semiautomatic resistor test method that greatly implements the gathering of data necessary to predict the operational performance of resistors.

NATURE OF LIFE TEST

SINCE resistors are a high-reliability component and one of the most commonly used components in electronic circuitry, proportionately large numbers of samples must be tested to obtain data from which performance characteristics can be properly evaluated. In simulating the usual operating conditions of resistors over a long period of time, the samples are subjected to a load-life test.

In the environmental test department of IBM's Owego, N. Y., Federal Systems Division, several hundred resistors of different types and manufacture are now undergoing load-life tests. Typically, this testing includes loading the resistors up to full-rated wattage during a 75% duty cycle (1½ hours on, and ½ hour off) at ambient temperatures up to 125 C for an average of 5,000 hours. Resistance measurements of the samples are taken weekly during the first 2,000 hours of test and every 2 weeks thereafter, until at least 5,000 test hours have been accumulated.

FORMER TEST METHOD

UNTIL RECENTLY, a test assembly used for resistor life tests was comprised of resistor mounting frames, high-temperature ovens, d-c power supplies, a timer to cycle the application of voltages to the resistors on test, a fuse panel, and complex manual switching units used to select the individual test resistors for measurements. The resistance measurements were taken with a manually operated 5-dial Wheatstone bridge.

The manual test method, while rendering precise measurements, is inherently slow and painstaking, and

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A special article recommended for publication by the AIEE Special Instruments and Auxiliary Apparatus Committee.

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a practical limit was imposed on the quantity of resistors that could be successfully handled. For instance, 1½ hours were required to measure and record 100 samples. The average set-up time for 100 samples was approximately 24 hours. This time included mounting of all test samples, connecting the individual resistor test leads to terminals in the switching units, connecting the test voltages to the samples, installing voltage-dropping resistors for each sample, and wiring a fuse panel. As additional groups of test samples were incorporated into this manual test system, difficulties increased because of the amount of time spent in testing and in the fabrication effort required to expand the test setup.

SEMIAUTOMATIC METHOD

In anticipation of a greatly expanded resistor test program, the resistor load-life test assembly was redesigned with the aim of eliminating or minimizing as many difficulties as possible. Redesign considerations centered around the following objectives:

1. Use of automatic measurement equipment.
2. Integration of all equipment into common housings.
3. Ease of operation and maintenance.
4. Uniformity and durability of assembly units and interconnecting cables.

These design concepts are embodied in the present test system, shown in Fig. 1.

AUTOMATIC UNITS

To accelerate the measurements of the samples under test, three automatic units are employed: a scanner, a commercially available digital ohmmeter, and an IBM electric typewriter. Fifty-pin connectors are used at selected points within the assembly for convenient interchange between individual resistor test frames, test loads, and automatic measuring units. Connector pins are gold-plated to minimize contact resistance.

The automatic units provide a rapid method for selecting, measuring, and recording resistance values. For example, a group of 100 resistor samples can be completely tested in 3⅓ minutes, at 2 seconds per resistor. In comparison, the time spent in measuring 100 resistors by the manual method totaled 1½ hours, nearly 1 minute per resistor. This marked contrast indicates the significant amount of time saved per resistor test sample with the automatic method, thus permitting a considerably greater amount of data to be gathered per given unit of time.

The scanner automatically selects 100 resistors sequentially, either individually or in groups. A group of resistors to be measured, e.g., 1 to 20, is preselected by setting a STOP switch on the scanner. A RESET SELECTOR

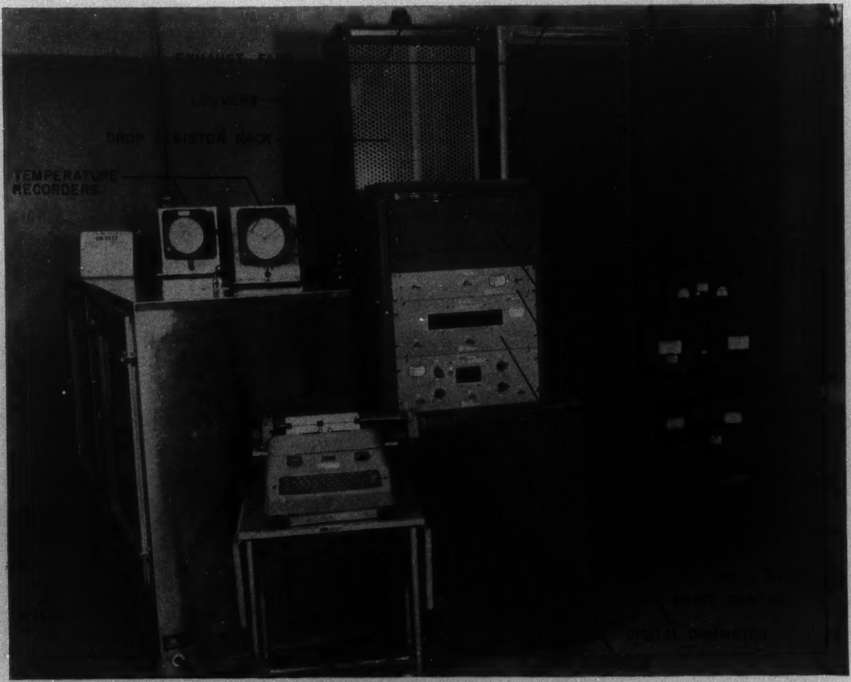

Fig. 1. Semiautomatic resistor load-life test assembly.

switch sets the starting point of the scanning process, and scanner position is displayed numerically (1–100) on an illuminated visual readout that corresponds to the particular sample under measurement. Each group of 100 samples must be manually and successively plugged into the scanner, since the input is limited to a pair of 50-pin connectors.

The digital ohmmeter shown in Fig. 2 is an automatic bridge. When the bridge is unbalanced by the test resistor R_x, an error signal is detected by the chopper and amplified. This error signal automatically adjusts the rheostat until the bridge is balanced. Contact closures of the digital rheostat operate a visual readout on the digital ohmmeter, a 5-digit Lucite plate array.

The resistance range of the digital ohmmeter is 0.1 ohm to 10 megohms, with accuracies extending from 0.01% on the low end to 0.1% on the high end of the resistance range.

Information received from the scanner and digital ohmmeter is relayed to the IBM electric typewriter through a commercially available control unit. The typewriter presents the test data in numerical form. A representative reading would be "21 1050.5 ohms," denoting a resistance value of 1,050.5 ohms for sample number 21.

HIGH-TEMPERATURE CHAMBERS

Highly insulated radiant-heat-type ovens with excellent temperature regulation accommodate a maximum of 10 resistor frames per oven, 100 resistors per frame. The ovens were modified with channeled tracks, for easy installation and removal of the frames. These are equipped with 168-hour temperature recorders to monitor oven temperature and to provide a record of oven performance.

TEST RESISTOR FRAMES

The test resistor frames are constructed to allow at least 1 inch of free air space between adjacent resistors mounted on the frame. To insure high insulation resistance at high temperatures, cables for the resistor frames are fabricated of Teflon-insulated wires that terminate at the 50-pin connectors. These connectors are plugged into a drop resistor rack where the appropriate test voltages are available.

STANDARD RELAY CABINETS

The other test assembly components—drop resistors, fuse panel, load time, current and voltage test panel, and power supplies—are contained in three standard relay cabinets (Fig. 1). Adequate ventilation is obtained through the use of cabinet louvers and exhaust fans mounted on the top of each cabinet.

Drop Resistors. A drop resistor, wired in series with each test resistor, is solder-mounted on bakelite terminal boards located in a relay cabinet. These drop resistors reduce the supply voltages to the required test voltages and prevent voltage variations across "in tolerance" resistors caused by severe resistance deviations of other test samples. In the present test setup, 60 terminal boards, secured to a rack within the cabinet, are capable of holding 1,500 drop resistors. Additional cabinet space is available to accommodate an additional 1,500 drop resistors. Cables from the drop resistor boards terminate at 50-pin connectors mounted on a cutout plate on one side of the cabinet, making them accessible from the cabinet's exterior.

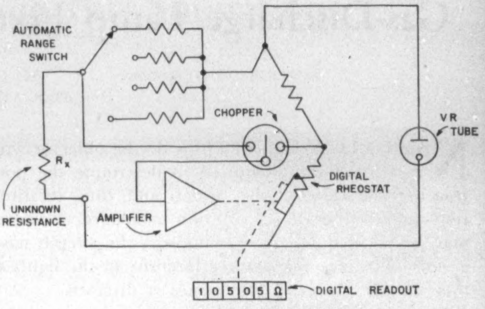

Fig. 2. Basic digital ohmmeter.

Power Source. Two relay cabinets house the fuse panel, load timer, and power supplies. The fuse panel, conveniently located in one of these cabinets, serves as a voltage distributor and circuit protector. The load timer permits time-sequenced power application to the test resistors. All power supplies are rack-mounted in the cabinets. The voltage and current test panel is utilized to measure output currents and voltages under load conditions; it also offers a means for removing the loads from individual power supplies.

CONCLUSION

Experience to date confirms that the automatic resistor test system is valid and also offers definite advantages. Since the introduction of the automatic test equipment, the amount of effort and number of manhours required to perform a given resistor life test has been appreciably reduced. This system would be a definite asset in any large-scale resistor test project, and its principles could also be applied to the testing of other types of components. In addition to the relative ease and substantial time-saving advantages, the inherent advantages of typewritten data presentation—neatness, conciseness, and easy reproducibility—are also realized.

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Gas-Discharge Lamp Fixtures for Aircraft Navigation

M. G. TYLER
ASSOCIATE MEMBER AIEE

NAVIGATION LIGHTS provide the observer with the information required to determine the position or orientation of the aircraft and, thus, its direction of travel, so that a collision avoidance maneuver may be executed. One way to improve the aircraft navigation lights is to increase the intensity of the lights so they may be observed from a greater distance.

Lamps utilizing gaseous discharge as a light source have been available for over 50 years. These lamps, now widely used, lack the simplicity of the incandescent lamp, but offer high lighting efficiency, inherent color characteristics, and excellent resistance to vibration and shock. It is required that a gas-discharge lamp have the following characteristics if it is to be suitable for use as an aircraft navigation light:

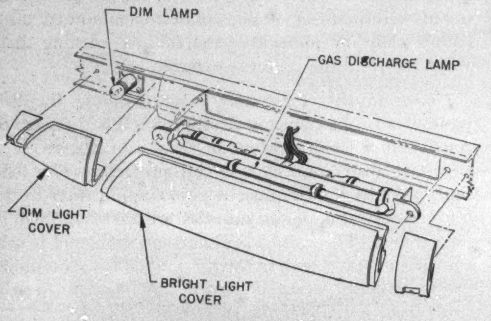

Fig. 1. Wing-tip lighting fixture.

1. Red, green, and white aviation colors meeting civil and military requirements.
2. Instant start to permit flashing.
3. Highest practicable intensity.
4. Flexibility in shape, to permit flush installation in the thin wing tips of high-performance jet aircraft.
5. High resistance to shock and vibration.
6. Operability in the range of temperatures encountered by aircraft.
7. Long life.

Gas-discharge lamps of the type used for high-quality luminous advertising signs most nearly meet the listed requirements.

High-performance aircraft have very thin wing tips. The gas-discharge lamp may be made small in diameter, so that it can be totally submerged in most aircraft wing tips with no degradation in aircraft performance. Figs. 1 and 2 show fixtures currently applied to the Navy model *A4D* type aircraft.

Continuously heated filament-type cathodes are provided in each end of the lamps to permit instant starting of the lights.

Since the gas-discharge lamp has a negative resistance characteristic, a current-limiting element must be connected in series with each lamp. A high-reactance autotransformer is provided for this ballast requirement. It must provide an initial high voltage of approximately 800 volts to strike the arc in the gas-discharge tube at the beginning of each half cycle and must then limit the arc current to 250 milliamperes, at which the lamp is operated. The gas-discharge lighting fixtures developed for aircraft use have

1. Higher intensity and greater coverage than the presently used incandescent lights.
2. High resistance to vibration and shock, as found in high-performance jet-type aircraft.
3. Long life equal to that of some types of military aircraft.

The use of these lighting fixtures in conjunction with a good anticollision beacon light system is expected to provide pilots with improved visual information so vitally needed to avoid air collisions.

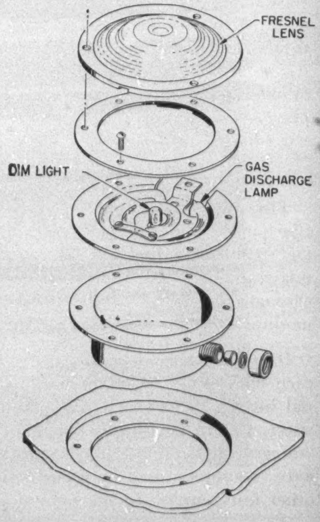

Fig. 2. Circular type taillight.

Digest of paper 60-1055, "Gas-Discharge Lamp Fixtures for Aircraft Navigation Lights," recommended by the AIEE Aero-Space Transportation Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Pacific General Meeting, San Diego, Calif., Aug. 8-12, 1960. Published in AIEE *Applications and Industry*, Jan. 1961, pp. 461-66.

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Reclosing Relay for Ring Bus Substations

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RING buses as herein discussed are divided by circuit breakers into sections, each of which provides termination of a source or load. Each source or load may be connected to its section by a motor-operated air-break switch. Such a ring bus poses problems not encountered with a straight bus. A fault trips both circuit breakers of a section. When the circuit breakers trip, it is important that the ring be restored as rapidly as possible, since a true bus does not exist. If the ring should become open at another location, several problems may develop, depending on design. Generators can be isolated, the system split apart, relaying handicapped by separating zero-sequence sources, or loads dropped unnecessarily. It is important that a faulted line be isolated and the ring restored as rapidly as possible to shorten the vulnerable period. The best method of accomplishing this is to automatize the two circuit breakers and the air-break switch.

Three possible fault conditions are considered when applying automatic reclosing on a ring-bus-type substation: (1) A transient line or bus fault with successful reclosure. (2) A persistent line fault with unsuccessful reclosures. The air-break switch is opened to isolate the line. A successful final reclosure restores the ring bus. (3) A persistent fault on the bus with unsuccessful final reclosure leaves the ring bus open.

An automatic reclosing device has been developel which operates the circuit breakers and air-break switch of a ring bus section. It disconnects a faulted line and restores the ring bus to service, after making required checks. The device consists of an assembly of 17 standard telephone-type relays and one 5-level 25-point rotary stepping switch. 24-cell or 60-cell battery operation is optional. The assembly is mounted in a double-ended, drawout case (Fig. 1).

Timing is obtained by standard automatic-telephone type circuits which operate the rotary switch by steps. Timing intervals can be adjusted from 3 to 15 seconds per step of the rotary switch. These intervals produce an over-all timing cycle adjustable from 1¼ to 6¼ minutes.

When the two terminal breakers trip, one breaker recloses in the desired time interval after verifying that the line is de-energized or energized and in-phase. If this or any subsequent reclosure is successful, the second breaker closes the ring, provided that desired in-phase and voltage conditions exist.

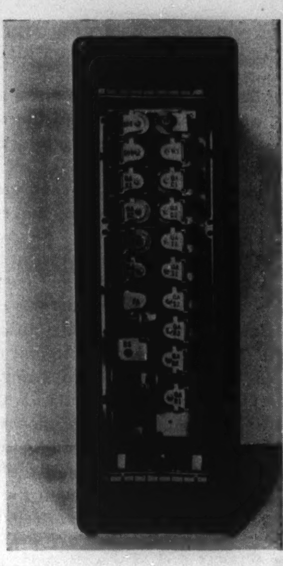

Fig. 1. Ring bus reclosing relay in drawout case.

If a persistent fault exists, the ring bus reclosing relay will, after verifying that both circuit breakers are open and the line is de-energized, open the motor-operated air-break switch, disconnecting the line. After verifying that the air-break switch is open, it will then close the first breaker, testing the bus section: (1) If this reclosure is successful, indicating a persistent fault on the line, the device verifies that in-phase conditions exist and closes the second breaker, restoring the ring bus to normal; (2) If this reclosure is unsuccessful, indicating a persistent fault on the bus section, the device ceases operation and locks out.

After any successful operation of closing both circuit breakers, the ring bus recloser will reset after predetermined intervals.

Many desirable interlocks may be interposed, such as lockout of reclosing due to faults in adjacent transformer sections, or temporary elimination of first reclosure during hot-line work. Interlocking of circuit breakers and air-break switch controls and line indications are all built into the device. Sequential operation of circuit breakers and air-break switches is positively assured under all conditions in a minimum of time. Accurate timing is maintained over a wide range of voltage, with flexibility of adjustment. Self-contained interlocking and checking features require a minimum of auxiliary devices. This results in savings of associated panel space and wiring. The reliability and value of the device is verified by operating experience.

Digest of paper 60-1267, "A Relay Designed to Meet Automatic Reclosing Requirements of Ring Bus Substations," recommended by the AIEE Substations Committee and the AIEE Relays Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Chicago, Ill. Published in AIEE *Power Apparatus and Systems*, Feb. 1961, pp. 1188-97.

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Grounding Grid Resistance of Small and Large Substations

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Data presented herein make possible the evaluation of grounding resistances of switch yards of all practical sizes. Included is the consideration of the influence of all significant design parameters, such as conductor size and depth of the grid below the earth's surface.

THE grounding resistance of large rectangular grids and plates of various length (L) to width (W) ratios (including squares $L = W$) have been investigated in earlier papers.[1-3] In addition to the L/W ratio as one parameter, a second parameter d/W ($1/2\,d$ being the depth of the grounding mat below earth surface) was used in the tabulation of the results. Since L and W indicate the size of the grid, and because d will not vary greatly in different applications, the ratio d/W will be a general measure of the size of the substation. This study is concerned with the extension and refinement of previous work[2,3] to relatively small substation and switch yards, down to areas of 5,000 square feet and L/W ratios between 1 and 4. Included is the consideration of plates since they provide the limiting values of grids with ever increasing mesh-numbers.

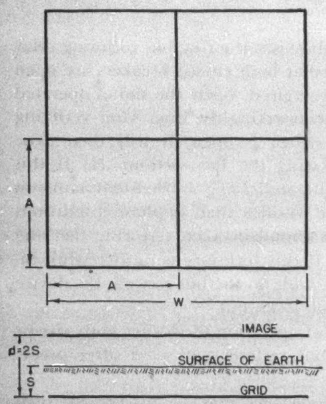

Fig. 1. Typical grounding grid configuration.

The method of calculation is the same as described in the earlier papers, but the computations were performed on the IBM *650* magnetic drum computer. Eight sig-

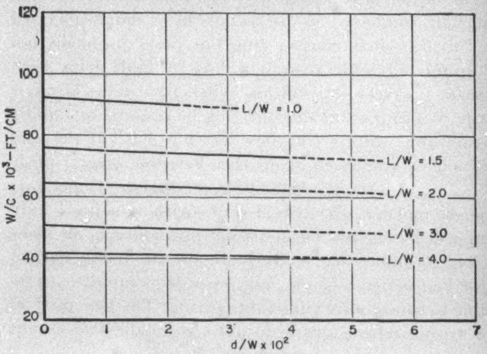

Fig. 2. W/C for plates.

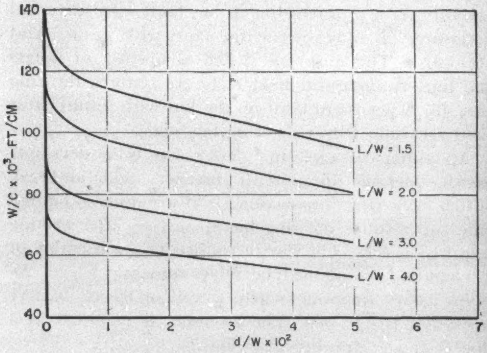

Fig. 3. W/C for 1-mesh grids.

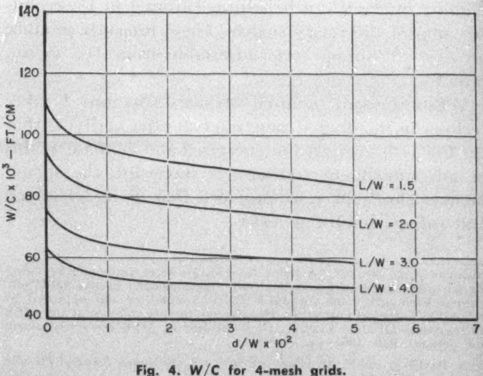

Fig. 4. W/C for 4-mesh grids.

A special article recommended for publication by the AIEE Substations Committee.

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The authors express their gratitude to the Armour Research Foundation for making available the facilities of the Computer Center for this study.

nificant figures were used throughout, and all values which duplicated previous computations checked them very well, so that errors are virtually eliminated.[4]

Tables 1 through 4 contain the results for the plate, the 1-mesh, 4-mesh and 9-mesh grids at L/W ratios between 1.0 and 4.0. All values are based on the r/W value 2.1213×10^{-4} for a typical square grid with an area of 20,000 square feet and a conductor r of 0.03 foot. The effect of increasing the conductor radius, when d is kept unchanged, is the same as keeping the conductor unchanged and increasing d in the same ratio. Therefore, changes resulting from other conductor radii can easily be taken into account.[3]

The values W/C, as given in the tables, are the basis for the resistance calculation. If W/C is equal to k, the total grounding resistance is

$$R\,(ohms) = \frac{\rho k}{2\pi W}.$$

where ρ is expressed in ohm-centimeters, k in feet per centimeter and W in feet.

Table I. Results for the Plate, *W/C* in ft/cm

	$L/W = 1.0$	$L/W = 1.5$	$L/W = 2.0$	$L/W = 3.0$	$L/W = 4.0$
d/W	W/C	W/C	W/C	W/C	W/C
0.00	0.09212	0.07562	0.06430	0.05036	0.04186
0.0005	0.09206				
0.0008		0.07555			
0.001			0.06424	0.05033	0.04183
0.0025	0.09183				
0.0041		0.07528			
0.005	0.09150		0.06404	0.05016	0.04172
0.0083		0.07495			
0.01	0.09091		0.06378	0.04997	0.04157
0.0167		0.07434			
0.02	0.08979		0.06325	0.04960	0.04129
0.04		0.07302	0.06218	0.04886	0.04073

Table II. Grid of One Mesh, *W/C* in ft/cm

	$L/W = 1.5$	$L/W = 2.0$	$L/W = 3.0$	$L/W = 4.0$
d/W	W/C	W/C	W/C	W/C
0.000	0.1393	0.1187	0.09213	0.07576
0.001	0.1292	0.1102	0.08577	0.07068
0.005	0.1186	0.1014	0.07917	0.06540
0.01	0.1141	0.09759	0.07634	0.06313
0.02	0.1097	0.09382	0.07351	0.06087
0.0425	0.09822	0.08366	0.06639	0.05501

Table III. Grid of Four Meshes, *W/C* in ft/cm

	$L/W = 1.5$	$L/W = 2.0$	$L/W = 3.0$	$L/W = 4.0$
d/W	W/C	W/C	W/C	W/C
0.000	0.1128	0.09581	0.07676	0.06349
0.001	0.1060	0.09014	0.07243	0.06001
0.005	0.09895	0.08425	0.06793	0.05639
0.010	0.09590		0.06599	0.05483
0.020	0.09287	0.07919	0.06405	0.05437
0.0425	0.08510	0.07281	0.05909	0.05048

Table IV. Grid of Nine Meshes, *W/C* in ft/cm

	$L/W = 1.5$	$L/W = 2.0$	$L/W = 3.0$
d/W	W/C	W/C	W/C
0.000	0.1019	0.08662	0.06744
0.001	0.09802	0.08342	0.06504
0.005	0.09121	0.07776	0.06081
0.010	0.09024	0.07695	0.06021
0.020	0.08655	0.07387	0.05791
0.0678	0.07763	0.06649	0.05205

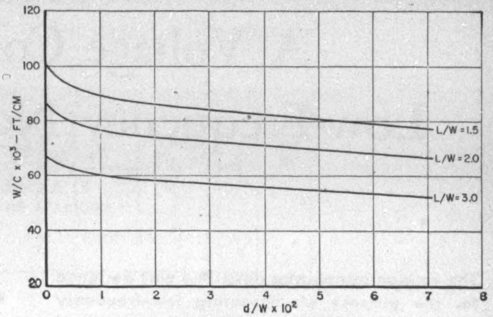

Fig. 5. W/C for 9-mesh grids.

Fig. 1. shows the typical configuration of a square grounding grid with four meshes. Fig. 2. shows k-values (W/C) for the plates, and Figs. 3 to 5 the k-values for the grids.

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◆

An Eye for the Sky

Man is dwarfed by the 60-foot antenna of one of the world's most powerful microwave radars now under construction at Cornell Aeronautical Laboratory, Inc. (CAL), Buffalo, N. Y. When the experimental 50-million-watt radar installation begins operating this Fall, CAL scientists will study the ability of "high peak power" radar to penetrate the earth's ionosphere in order to detect and track ballistic missiles and satellites with greater accuracy and at considerably longer range than is now possible. CAL is conducting its high peak power radar research program for the U.S. Defense Department's Advanced Research Projects Agency under the supervision of the Army Rocket and Guided Missile Agency. The 50-million-watt transmitter for the new installation was designed and built by FXR, Inc., of Woodside, L. I., N. Y.

A Voltage Comparator for Low-Frequency Noise Measurements

F. A. SPELMAN
ASSOCIATE MEMBER AIEE

The voltage comparator described was designed for the purpose of measuring low-frequency noise in transistors. In addition, it can be used to study any noise phenomenon within the 50- to 5,000-cycle spectrum.

EXPERIMENTAL STUDY has classified low-frequency transistor noise into two types: the theoretically predicted noise, usually predominant at frequencies greater than 1 kc, and the unpredicted "excess noise," generally predominant at frequencies lower than 1 kc. Excess noise (also called $1/f$ noise because of its increase with decreasing frequency) makes transistor circuit design difficult in low-frequency small-signal applications. In order to translate excess noise into a usable noise figure, we must measure the noise and study its properties carefully.

Since noise is studied in statistical terms, we must measure excess noise in statistical terms. Given a device that produces an output for input signals of only one voltage level, we can measure the probability density function of any waveform. Such a voltage slicer of infinitesimal voltage width and variable voltage level, usel to control a gate, will do just that. If a signal of the desired level is present, the slicer opens the gate for the exact time that the proper signal level is at the input. For any other signal level, the gate remains closed. Thus, for any unit of time a measure of the percentage of time that the gate is open is a measure of the probability that the input signal exists at the desired level. A voltage slicer of very small (though not infinitesimal) voltage width can be built, but the time spent on the slicer is not warranted since the same job can be done with a simpler device, the voltage comparator.

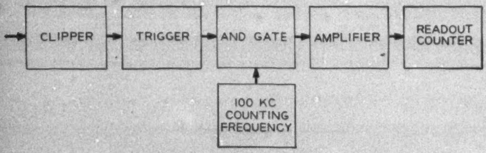

Fig. 1. Block diagram of the noise-voltage comparator.

The voltage comparator does not measure the probability density function of a given waveform. Rather, it measures the probability that a waveform exists at or above voltage level. This probability is the integral of the waveform's probability density function, its probability function. Hence, if we use a voltage comparator to measure the probability function of any waveform, we can differentiate the result, either analytically or graphically, and obtain the desired probability density function.

A voltage comparator in the form of Fig. 1 readily measures probability. When a waveform is fed through a clipper into a trigger, the trigger delivers an output for any input voltage at or above the clipping level. The trigger output is now fed into an AND gate together with a counting frequency f. Every time that there is an input voltage signal above the clipping level, pulses of frequency f appear at the output of the gate. The gate output is counted over a given length of time T. The ratio of pulses counted per period to the product fT is a direct measurement of the probability that the input signal exists at or above the given voltage level. If the clipper is variably biased, then the clipping level can be changed at will, and the probability function of any input waveform can be measured.

The comparator discussed here measures input signals from 0 to –10 volts in amplitude, from 50 cycles to 5,000 cycles. There are four black boxes: the variably biased clipper, the trigger, the gate, and the output amplifier.

The clipper (Fig. 2) uses a *1N658* silicon diode. The diode is normally backbiased by the d-c potential of the slider arm of the 1,000-ohm potentiometer. The resolution of the bias adjustment is 0.01 volt when the voltage across the 1,000-ohm potentiometer is 10 volts. The two variable resistors (1,200 and 200 ohms) adjust the zero and full-scale range of the clipper.

The trigger circuit employs two *2N655* transistors, T_1 and T_2. T_1 is connected as an emitter follower which is emitter coupled to T_2. When an input signal is greater than the clipping level set on the level-setting potentiometer, T_1 conducts, thus increasing the voltage drop across the 2,700-ohm emitter resistor, and turning T_2 off. When the input signal is less than clipping level, T_1 is cut off and T_2 conducts. Since there is no feedback in the trigger circuit, it has no hysteresis effect.

Essentially full text of the 1958-59 first prize paper presented at the District 8 meeting of Student Branches for the purpose of Branch papers competition. Recommended for publication by the AIEE Educational Publications Committee.

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The author expresses his appreciation to Dr. M. M. McWhorter, Prof. Rudolf Panholzer, and P. O. Lauritzen of Stanford University for their valuable advice and to the Hewlett-Packard Company for the loan of one of their counters for demonstration purposes.

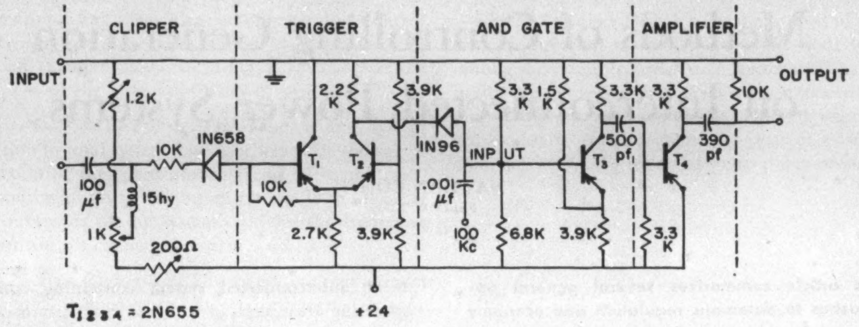

Fig. 2. Circuit diagram for the noise-voltage comparator.

The trigger, therefore, turns the AND gate on and off at the same voltage level.

The AND gate employs a *1N96* germanium diode and a common emitter transistor amplifier. The diode has a 3-volt back bias while T_2 is conducting. The base circuit of T_3 has a 2.5-volt back bias. Hence, unless T_3 is receiving the 100-kc counting frequency pulses (2 volts peak) and T_2 is cut off (input signal greater than clipping level), T_3 is cut off.

The output of the AND gate is a-c coupled to the output amplifier, another common emitter transistor amplifier. The rise time of the output stage (16 microseconds) is determined by its output circuit. The 100-kc output is 6 volts peak-to-peak, more than enough voltage to exceed the threshold of the Hewlett-Packard *521* counter, which is used for probability readings. The counter is gated over a one-second interval; probability is read directly on the counter: a count of 100,000 corresponds to a probability of one; a count of zero corresponds to a probability of zero.

The comparator was calibrated with a 1,000-cycle sine wave of 20 volts-to-peak amplitude. The measured probabilities lie within 1% of full-scale reading (probability of ½). Thousand-cycle calibration results are shown in Table I.

Frequency response was measured from 5 to 5,000 cycles. The measured probabilities lie within 4% of full-scale reading (see Table II). The upper frequency limit of 5 kc is determined by the lack of resolution that occurs as the input frequency approaches 100 kc; i.e., a single gained or lost frequency pulse becomes more significant as the frequency increases.

The low-frequency limit is determined by the input circuit. The input is coupled with a 100-µf capacitor to keep the d-c component of the input signal from the level-setting potentiometer in the clipping circuit. To maintain high a-c impedance and to maintain a low d-c impedance so that the potentiometer is an accurate voltage reference, a 15-henry inductor was added between the sliding arm of the potentiometer and the input capacitor. But the inductor–capacitor combination resonates at 5 cycles, and signals of a few cycles frequency can excite the resonant circuit, so the low-frequency limit was set at 50 cycles.

Table I. Results of 1,000-Cycle Calibration

Amplitude Level, volts	Measured Probability	Actual Probability
0.0	0.500	0.500
−2.5	0.419	0.419
−5.0	0.332	0.333
−7.5	0.227	0.229
−8.66	0.162	0.166
−10.0	0.000	0.000

Table II. Frequency Response Under Various Conditions

Amplitude	Frequency Response at				
Level, volts	5 cps	50 cps	500 cps	1,000 cps	5,000 cps
0.0	0.497	0.498	0.498	0.500	0.510
−5.0	0.350	0.330	0.330	0.333	0.340

CONCLUSIONS

THE VOLTAGE COMPARATOR should work well as a probability meter for noise signals. It provides a means for measuring the probability function of any waveform in the 50- to 5,000-cycle band to within 4% accuracy, and should help to clarify the study of noise.

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Methods of Controlling Generation on Interconnected Power Systems

NATHAN COHN
FELLOW AIEE

This article summarizes several general approaches to automatic regulation and economy dispatch that have evolved in recent years and suggests a system of classifying them by their basic scope and method.

THERE HAS BEEN increasing use in recent years of area-wide generation control systems which place most or all of an area's generating facilities under automatic control. Advances in the technology of energy conversion have resulted in a corresponding disparity between the heat rates of the alternative generating sources which might be used to satisfy consumer demand. This disparity, coupled with varying fuel costs and varying transmission loss factors, permits significant fuel savings as a result of automatic economic loading—economy dispatch—of various sources.

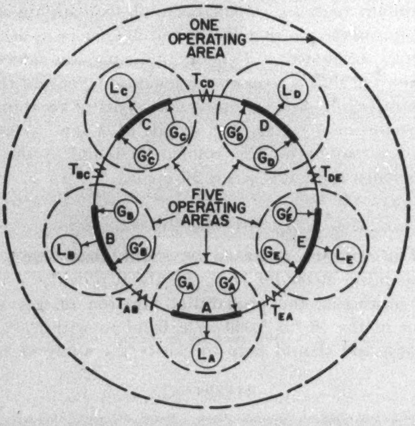


Fig. 1. Simplified representation of an interconnected system.

TYPES OF INTERCONNECTIONS

FIVE of the country's six major interconnections operate on a "multiple area" basis, a designation applied to an interconnected system containing constituent operating areas, each of which is to absorb its own load changes. Economy interchange, furnishing lower-cost energy from an area which has it in excess, to another area where it is used in place of local higher-cost energy, is achieved by scheduling and maintaining interarea power flows. Standard practice for most multiple-area interconnections is for each area to regulate its interchange with the interconnection as a whole, using net interchange tie-line bias control.

One major interconnection normally operates on a "single area" basis. This designation infers that load changes, regardless of where on the system they occur, are allocated for economy dispatch to the next-in-line sources regardless of where on the system they are located. Economy interchange between companies is not scheduled in blocks as on multiple-area systems. Economy interchange occurs, however, whenever—in achieving system economy dispatch—one company alters its generation in response to a load change that occurs on another company's network.

THE AREA CONTROL PROBLEM

THE OBJECTIVES of generation control are (1) to match total system generation to total system demand, and (2) to obtain the requisite total from available system sources with such allocation among them as will fulfill system operating criteria.

On a single-area system, the objective of such allocation is to achieve economy dispatch of the system.

On a multiple-area system, the allocation objective is in itself twofold. There is the allocation step of causing each area to absorb its own load changes. There is then the allocation step of achieving economy dispatch within the area.

A simplified representation of an interconnection having five participating companies, *A* through *E*, is shown in Fig. 1. Simplified representations of tie-lines *T*, loads *L*, and alternative generating sources *G* and *G'*, corresponding to all of each company's tie-lines, loads, and generating sources, are shown. These companies may operate as a single-area system, as five separate areas, or they may operate with any intermediate combination of areas, which are defined in each instance by the boundary ties that are metered to make up each area's net interchange with the interconnection as a whole.

Condensed text of paper 60-846, presented at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Recommended for publication by the AIEE System Engineering Committee. Scheduled for publication in AIEE *Power Apparatus and Systems,* 1961.

Nathan Cohn is with the Leeds & Northrup Company, Philadelphia, Pa.

A functional and block diagram of generation control for a typical area of a multiple-area system—area *A* of Fig. 1, for example—is shown in Fig. 2. It illustrates the three steps of the generation control problem.

Step 1—System Governing. The match of total system generation to total system load is achieved by the aggregate action of the speed governors on all of the operating sources of area *A* acting in concert with all other speed governors of the system, and by the frequency coefficient of all connected system load.

Step 2—Area Regulation. The regulating requirement for the area, defined as its "area requirement," is computed from the following equation:

$$E = (T_0 - T_1) - 10B(F_0 - F_1) = \Delta T - 10B(\Delta F) \qquad (1)$$

where

E = area requirement, megawatts

T_0 = area net interchange schedule, megawatts, at normal frequency

T_1 = prevailing area net interchange, megawatts

F_0 = frequency schedule, cycles per second

F_1 = prevailing frequency, cycles per second

B = area bias, megawatts per one-tenth cycle

Area regulation is achieved by applying corrective control action to area sources until area requirement is reduced to zero.

Step 3—Economy Dispatch. In the process of reducing area requirement to zero, there is the need for determining the extent to which each source shall participate in this control action so that sources are loaded for optimum economy. Such loading is achieved when sources are loaded to equal incremental costs of power delivered, defined by the following general equations:

$$\lambda = \frac{\dfrac{dF_n}{dP_n}}{1 - \dfrac{\partial L}{\partial P_n}} = \frac{\dfrac{dH_n}{dP_n} f_n}{1 - \dfrac{\partial L}{\partial P_n}} \qquad (2)$$

where

λ = area incremental cost of power delivered

$\dfrac{dF_n}{dP_n}$ = incremental cost of power generated at source n

$\dfrac{\partial L}{\partial P_n}$ = incremental transmission loss for source n

$\dfrac{dH_n}{dP_n}$ = incremental heat rate for source n

f_n = incremental fuel cost for source n

The basic problem of economy dispatch is to compute the desired outputs for each of the area sources in such manner that (1) all area sources will be operating to a

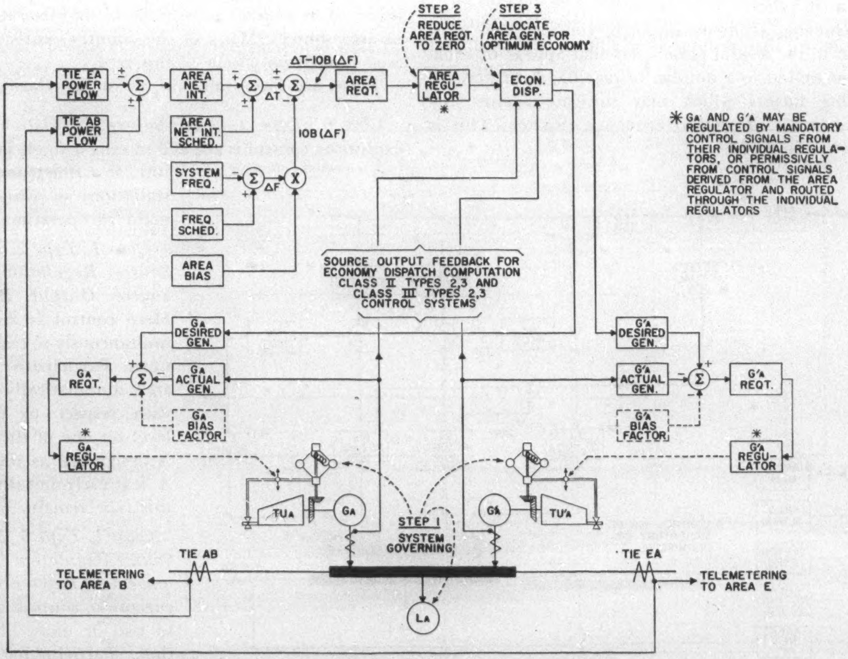

STEP 2
REDUCE AREA REQT. TO ZERO
STEP 3
ALLOCATE AREA GEN. FOR OPTIMUM ECONOMY
TIE EA POWER FLOW
TIE AB POWER FLOW
Σ
AREA NET INT.
AREA NET INT. SCHED.
SYSTEM FREQ.
FREQ. SCHED.
AREA BIAS
ΔT
ΔF
X
10B(ΔF)
ΔT-10B(ΔF)
AREA REQT.
AREA REGU-LATOR
ECON. DISP.
* GA AND G'A MAY BE REGULATED BY MANDATORY CONTROL SIGNALS FROM THEIR INDIVIDUAL REGULATORS, OR PERMISSIVELY FROM CONTROL SIGNALS DERIVED FROM THE AREA REGULATOR AND ROUTED THROUGH THE INDIVIDUAL REGULATORS
SOURCE OUTPUT FEEDBACK FOR ECONOMY DISPATCH COMPUTATION CLASS II TYPES 2,3 AND CLASS III TYPES 2,3 CONTROL SYSTEMS
GA DESIRED GEN.
GA REQT.
GA ACTUAL GEN.
GA BIAS FACTOR
GA REGU-LATOR
G'A DESIRED GEN.
G'A ACTUAL GEN.
G'A REQT.
G'A BIAS FACTOR
G'A REGU-LATOR
TUA
GA
G'A
TU'A
STEP I
SYSTEM GOVERNING
TIE AB
TIE EA
TELEMETERING TO AREA B
TELEMETERING TO AREA E
LA

Fig. 2. Functional and block diagram of an automatic generation and power flow control system as applied to area A of Fig. 1. Source bias factors, shown in broken lines, are used where control execution is of the mandatory type.

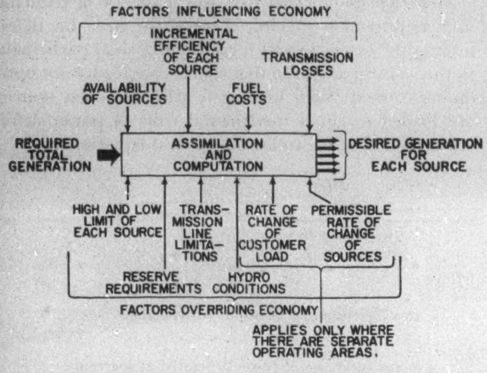

FACTORS INFLUENCING ECONOMY
INCREMENTAL EFFICIENCY OF EACH SOURCE
TRANSMISSION LOSSES
AVAILABILITY OF SOURCES
FUEL COSTS
REQUIRED TOTAL GENERATION
ASSIMILATION AND COMPUTATION
DESIRED GENERATION FOR EACH SOURCE
HIGH AND LOW LIMIT OF EACH SOURCE
TRANSMISSION LINE LIMITATIONS
RATE OF CHANGE OF CUSTOMER LOAD
PERMISSIBLE RATE OF CHANGE OF SOURCES
RESERVE REQUIREMENTS
HYDRO CONDITIONS
FACTORS OVERRIDING ECONOMY
APPLIES ONLY WHERE THERE ARE SEPARATE OPERATING AREAS.

Fig. 3. Factors to be considered in determining how the total generation required of an area is to be allocated among available area sources.

common area lambda, and (2) the sum of the desired outputs of all sources will equal the total generation required of the area at that time. For each prevailing area condition, there is a unique value of lambda that corresponds to the total required area generation.

It can therefore be postulated that to establish the appropriate lambda, there must be knowledge of the total generation then required of the area. This knowledge can be implied, as in some executions, or it can be direct, as in others.

In achieving economy dispatch, consideration must be given to the several parameters that appear in equation 2, as well as to a number of possible constraints or overriding factors which may mitigate against the achievement of theoretical economy dispatch. This is summarized in Fig. 3.

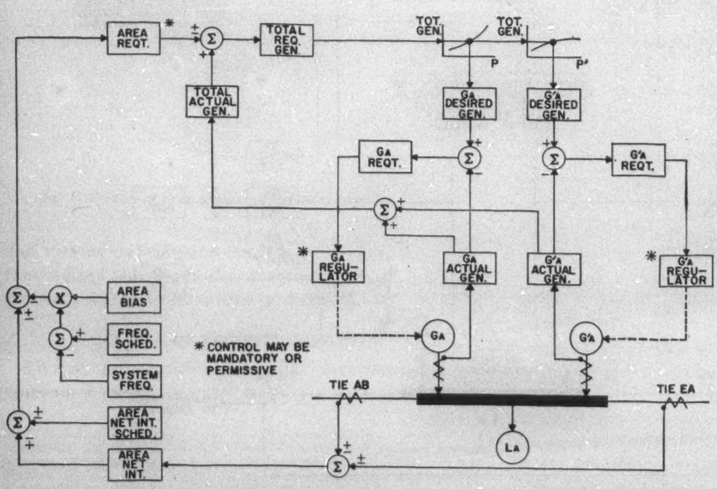

AREA REQT.
*
±
+
Σ
TOTAL REQ. GEN.
TOTAL ACTUAL GEN.
TOT. GEN.
P
TOT. GEN.
P'
G_A DESIRED GEN.
G'_A DESIRED GEN.
G_A REQT.
G'_A REQT.
G_A REGULATOR
G_A ACTUAL GEN.
G'_A ACTUAL GEN.
G'_A REGULATOR
X
AREA BIAS
FREQ. SCHED.
SYSTEM FREQ.
AREA NET INT. SCHED.
AREA NET INT.
* CONTROL MAY BE MANDATORY OR PERMISSIVE
G_A
G'_A
TIE AB
TIE EA
L_A

Fig. 4. Class II, Type 3 flexible program control. The common reference is a feedback from source outputs combined with a feed-forward from area requirement.

CLASSIFICATION OF CONTROL SYSTEMS

While there is essentially universal agreement in this country on the basic approach to net interchange tie-line bias control for area regulation, there are a number of differences in the executions that have been used to achieve automatic economy dispatch. Some of these differences reflect normal evolution and innovation in the state of the art; others reflect the competitive technologies of a competitive economy.

To permit a ready review of the basic nature of various control systems, to highlight the evolution of the art, and to clarify the differences between older systems and the newest techniques, it is convenient to classify control approaches into various groups. Since there are at present no formal classifications for various types of generation controls, such classifications will be introduced for the present discussion. Three broad classifications have been established, based on the portions of the integrated multiple-area problem which the control system undertakes to solve and on the nature of the programming technique that is utilized. Each of these three classes is additionally subdivided by the nature of the common reference that is used for establishing source loadings.

CLASS I CONTROLS—AREA REGULATION ONLY

A Class I control system is one which undertakes to provide area regulation only, step 2 of the multiple-area problem. Economy dispatch within the area is achieved by manual adjustment of the generation levels of area sources. Many of the country's early multiple-area installations were of this type.

There are three subdivisions in this class:

Class I, Type 1. Single-Source Regulation. In this execution, control is applied to only a single generating unit at a time. Very few installations of this type remain in operation.

Class I, Type 2. Multiple-Source Regulation, Single-Source Output Reference. Here control is applied simultaneously to two or more units. Participating sources are automatically loaded with respect to the load level on one of them which is designated as the master. A few early installations of this type remain.

Class I, Type 3. Multiple-Source Regulation, Area Requirement Reference. In this execution, control is applied to two or more units at a time. Participating sources are automatically loaded with respect to a reference

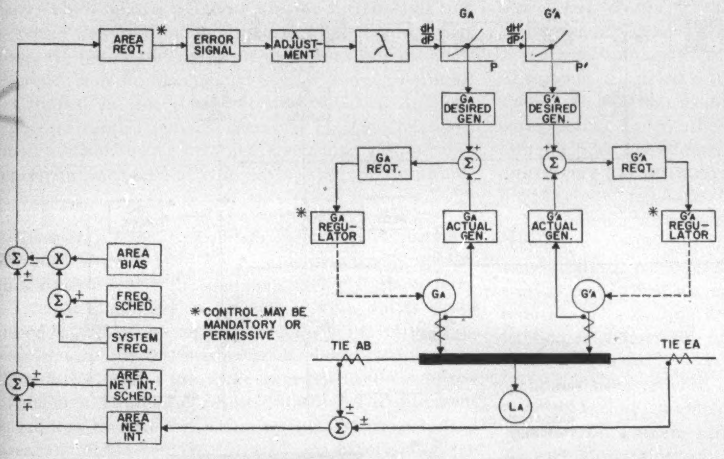

GA
G'A
AREA REQT.
*
ERROR SIGNAL
ADJUSTMENT
λ
dH/dP
dH'/dP'
P
P'
GA DESIRED GEN.
G'A DESIRED GEN.
GA REQT.
G'A REQT.
Σ
*
GA REGULATOR
GA ACTUAL GEN.
G'A ACTUAL GEN.
G'A REGULATOR
AREA BIAS
FREQ. SCHED.
SYSTEM FREQ.
AREA NET INT. SCHED.
AREA NET INT.
X
* CONTROL MAY BE MANDATORY OR PERMISSIVE
TIE AB
TIE EA
LA

Fig. 5. Class III, Type 1 economy dispatch. The common reference lambda adjustment is achieved by feedback through the area control loop.

derived from area requirement. Very few installations use this arrangement by itself, though it is frequently used in combination with economy dispatch systems to achieve more rapid area regulation.

CLASS II CONTROLS—ECONOMY DISPATCH, FLEXIBLE PROGRAMMING

A Class II control is an area control system that is applied to most or all of the generators of the area and which, in achieving automatic dispatch, simultaneously achieves the objectives of area regulation. A common reference is used for source loading. The distinguishing characteristic of this class is that the loading programs are manually set. Programs may be set to achieve true economic dispatch, or to recognize the need for overriding economy dispatch with factors shown in Fig. 3. This class generally requires that programs be reset for various combinations of participating sources.

Subdivisions in this class are identified by the nature of the common reference that is used for programming source loading.

Class II, Type 1. Single-Source Output Reference. This designation applies to a control where the reference for source programming is the output of one of the sources which is designated as master. Such programming tends to be complex, depending on which source is the master, and which combination of sources is in operation. One of the country's pioneer area-wide installations was of this type, and is still in successful operation.

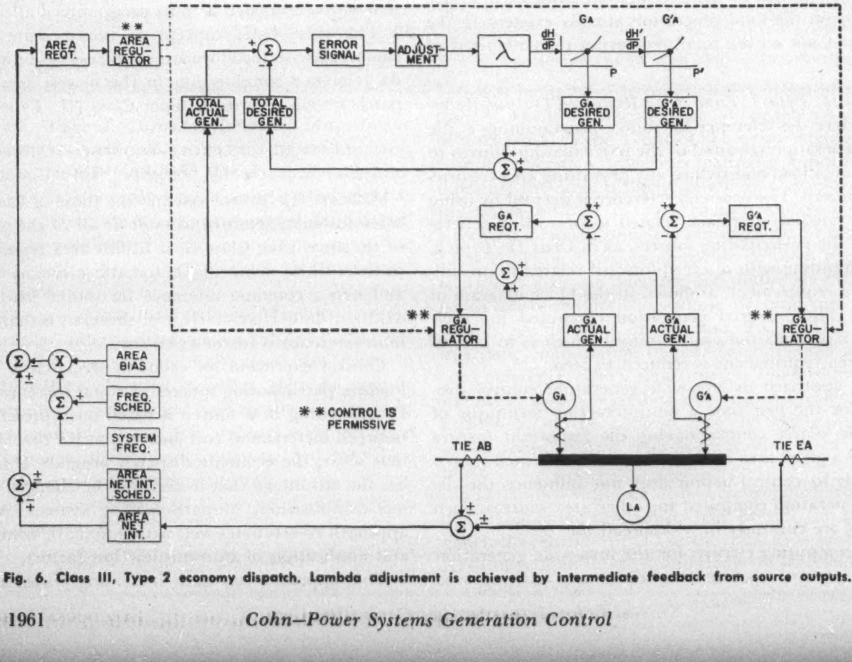
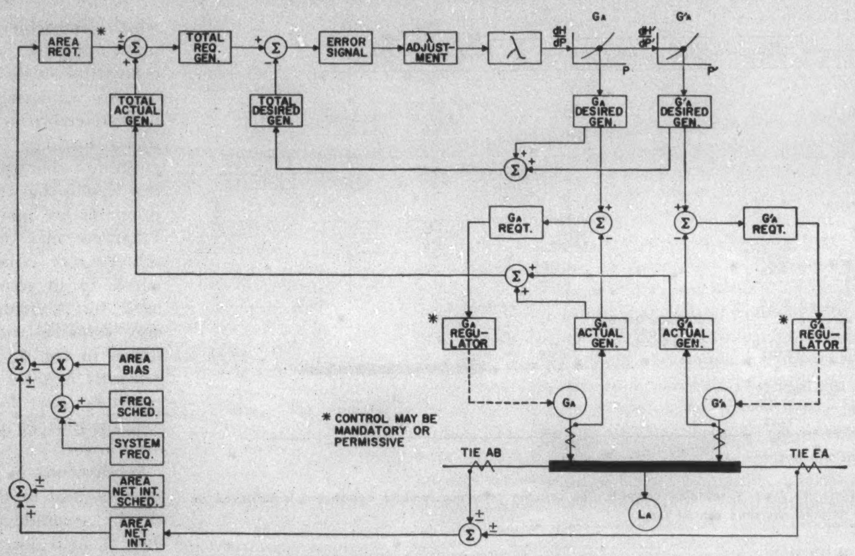

GA
G'A
AREA REQT.
**
AREA REGULATOR
Σ
ERROR SIGNAL
ADJUSTMENT
λ
dH/dP
dH'/dP'
P
P'
TOTAL ACTUAL GEN.
TOTAL DESIRED GEN.
GA DESIRED GEN.
G'A DESIRED GEN.
GA REQT.
G'A REQT.
**
GA REGULATOR
GA ACTUAL GEN.
G'A ACTUAL GEN.
**
G'A REGULATOR
X
AREA BIAS
FREQ. SCHED.
SYSTEM FREQ.
AREA NET INT. SCHED.
AREA NET INT.
** CONTROL IS PERMISSIVE
TIE AB
TIE EA
LA

Fig. 6. Class III, Type 2 economy dispatch. Lambda adjustment is achieved by intermediate feedback from source outputs.



* CONTROL MAY BE MANDATORY OR PERMISSIVE

Fig. 7. Class III, Type 3 economy dispatch, based on equation 7. Lambda adjustment is achieved by intermediate feedback from source outputs combined with feed-forward from area requirement, and is independent of area control loop.

Class II, Type 2. Total Area Output Reference. This designation applies where the reference for source programming is the total prevailing output of participating sources. Data for the reference would be obtained from an intermediate feedback related to prevailing output of participating sources. A limitation of this approach is that computed generation desired from each source is based on the total generation already existent in the area, and not on the total generation then required of the area.

Class II, Type 3. Total Area Required Output Reference. Here the reference for source programming is the total generation required of the participating sources to satisfy area load and reduce any prevailing area requirement to zero. The common reference is derived by using an intermediate feedback related to prevailing generation of the participating sources, as in Class II, Type 2, but combining with it a feed-forward related to prevailing area requirement, as shown in the block diagram of Fig. 4. Thus, desired generation computed for each source represents the source output which is to prevail after area requirement is reduced to zero.

This approach to area-wide generation control provided for the first time a noninteracting technique of multiple source control having the important feature that for a given area load, the rate at which each source responds to control action does not influence the desired generation computed for other area sources. Such controls are currently in widespread use.

The computing circuits for the area-wide generation type of control operate to allocate any existing area requirement E in accordance with the following relationship:

$$E = \Sigma S_n \qquad (3)$$

where S_n is the generation-change requirement for each area source n. It is the generation change required of that source to match it to its programmed allocation.

The same basic concept of intermediate feedback combined with feed-forward is utilized for unique lambda reference computation in the newest economy dispatch system described under Class III, Type 3.

CLASS III CONTROLS—ECONOMY DISPATCH, FIXED PROGRAMMING

A Class III control system, like those of Class II, applies automatic control to most or all of the generators of the area. Like Class II, it fulfills area regulation objectives while achieving automatic economy dispatch, and uses a common reference for source loading. The distinguishing characteristic of this class is that the common reference is incremental cost.

Control execution for economy dispatch is based on loading participating sources to equal incremental cost. Programming of a source is based on a preset relation between incremental cost and output for that source. In that sense, the economy dispatch program is fixed and has the advantage that it need not be changed for various combinations of participating sources. Also, this approach co-ordinates well with automatic computation and application of transmission loss factors.

This approach has been increasingly used in recent years. The common reference may be incremental cost of power delivered or, in instances where transmission losses are not considered to be significant, the common reference may be incremental cost of power produced.

Grouped in this class, but subdivided as different types, are control systems where the common reference either continuously represents incremental cost, or only represents incremental cost during certain conditions of balance.

Class III, Type 1. Lambda Reference Adjustment Through Area Control Loop. This designation applies to a control where the common reference is not independently computed as incremental cost, but is established by a floating search initiated from prevailing area requirement. In this method of lambda determination there is not a direct use of the total generation required of the area. Lambda is adjusted until area requirement is reduced to zero. By that inferential means, required area lambda is related to required area generation. Control is a series cascade, with feedback through the power network and the boundary tie-lines determining when the reference lambda has been properly established.

A simplified block diagram showing the application of this type of control is shown in Fig. 5. For simplicity, no transmission loss or fuel factors are shown or considered in this schematic diagram (or in Figs. 6 or 7) and it is assumed that the lambda reference may be regarded as incremental heat rate of the sources.

In this method, the common reference accurately represents the lambda required for prevailing conditions only when the two following relations are fulfilled:

$$E = 0 \tag{4}$$

and

$$S_n = 0 \tag{5}$$

Several controls utilizing this type of economy dispatch are in operation at present.

Class III, Type 2. Lambda Reference Adjustment Using Area Output Feedback. In this type of control, the common lambda reference is established independently of the area control loop. Lambda adjustment is based on a comparison between summated desired generation of the participating sources and total prevailing area generation. A basic block diagram for this type of control is shown in Fig. 6.

It will be noted that this method of lambda determination uses an intermediate feedback from the output of participating sources, in the manner illustrated in Fig. 2. It will be observed, however, that the lambda thus determined corresponds only to the total generation already carried in the area, and makes no provision for further area generation changes needed to reduce any prevailing area requirement to zero.

At least one installation of this type of control is in use at the present time.

Class III, Type 3. Lambda Reference Adjustment Using Area Output Feedback and Area Requirement Feed-Forward. This is one of the newest of the economy dispatch techniques. Here the computation for lambda adjustment is carried a step further than in Class III, Type 2. In addition to the intermediate feedback from participating sources, the lambda adjustment computation includes a feed-forward from prevailing area requirement. This is illustrated by the block diagram of Fig. 7.

The lambda adjustment is based on an error signal derived by comparing the computed desired generation for all the participating sources with the total generation required of the area to carry its own load and reduce any prevailing area requirement to zero. The lambda thus determined, therefore, corresponds to the total area generation that will prevail after area requirement has been reduced to zero. Similarly, the desired generation thus computed for each of the participating sources represents the generation level that is to prevail for each source after area requirement has been reduced to zero.

The equation for lambda adjustment in Fig. 7 is as follows:

$$E + \Sigma G_n = \Sigma D_n \tag{6}$$

or

$$E = \Sigma D_n - \Sigma G_n = \Sigma (D_n - G_n) \tag{7}$$

from which

$$E = \Sigma S_n \tag{8}$$

where

E = area requirement

G_n = actual generation of each participating source

D_n = computed desired generation for each participating source

S_n = source requirement for each participating source

It will be noted that equation 8 is identical to equation 3, which represented the allocation relationship of the Class II, Type 3 control. This equivalence will be readily understood when it is realized that both control types use the same ultimate reference of feedback from prevailing outputs of participating sources combined with feed-forward from area requirement. In the case of Class II, Type 3, the combination of these parameters is used as a direct reference for source allocation and yields source requirements whose algebraic sum is equal to area requirement. In the case of Class III, Type 3, this same combination of parameters is used as a primary reference, which results in the establishment of a secondary common lambda reference at a value causing fulfillment of the relation that the algebraic sum of source requirements equals prevailing area requirement.

The lambda thus established continuously represents the incremental cost which will prevail for the total generation then required of the area. It is based on direct rather than inferred knowledge of the total generation need of the area. Control execution is still a cascade, but the common lambda reference is now uniquely established independently of the action or response of source regulators and independently of feedback through the area control loop and the boundary tie-lines. Like Class II, Type 3, and unlike Class III, Types 1 and 2, this is a noninteracting control, and the desired generations computed for participating sources at a prevailing area load are unaffected by the rate at which each participating source responds to control action.

For simplification, the block diagram of Fig. 7 does not include transmission loss or fuel cost factors. A block diagram of a Class III, Type 3 control based on equation 8 rather than equation 6 and including these additional factors is shown in Fig. 8.

A number of installations of this type have been made during the past two years. Others are in the process of installation.

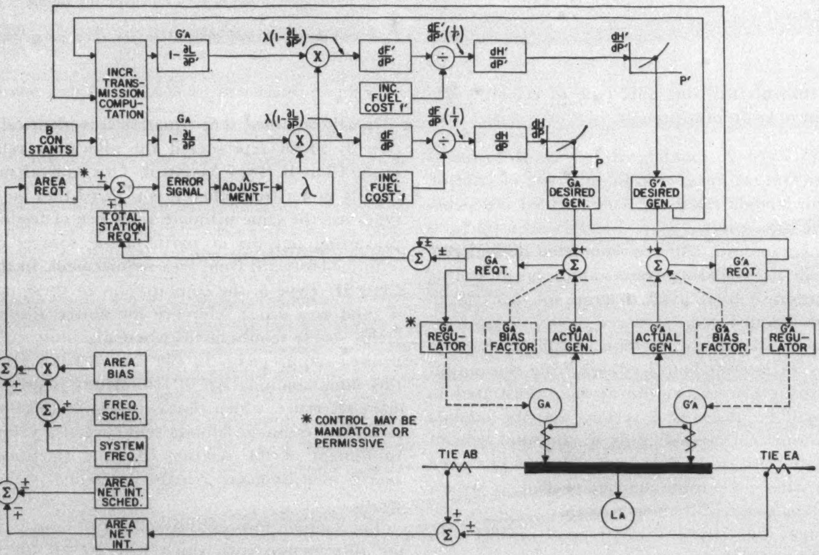
A feature of a Class III, Type 3 control system, as has been noted, is that the lambda and desired generation computations are independent of actual control action. Thus the computation portion of the equipment can be isolated from control operation and can be used to derive data on area conditions that will prevail for various operating situations.

COMBINATIONS

Control systems have been classified in this article by the basic concepts which they employ. It will be understood that each of the classes and subdivided types could utilize optional features and arrangements, and some installations might represent combinations of more than one class. It is beyond the scope of this article to analyze all of these variations; however, a few remarks will be made about some of them.

Area Assist Action. In executing economy dispatch on multiple-area systems, a normal objective would be to assign generation changes to area sources so that area regulation is achieved at the same time that the economy dispatch objective is fulfilled. In such an execution, each area load change would be assigned to that area source that is to absorb it for economy dispatch. Each area load change would thus be absorbed only once, and generation changes within the area would be minimized. In some areas, however, the permissible rate of change of the generation sources which are next in line to pick up load changes for economy dispatch may not be sufficiently great to satisfy fully the needs of area regulation. That is to say, such rigid economy dispatch may not reduce area requirement to zero rapidly enough or maintain it within acceptable limits.

In such cases, the control can be arranged to make an initial assignment of generation changes to units not then in line to retain them for economy dispatch, and then re-allocate them to the economy dispatch sources at rates permissible for those sources. This is the significance of the two arrows marked "Rate of Change of Customer Load" and "Permissible Rate of Change of Sources" shown entering the bottom of the "Assimilation and Computation" block in Fig. 3. Such control action has been identified as area assist, fringe, or pro-



INCR. TRANSMISSION COMPUTATION
B CONSTANTS
G'_A
$1-\frac{\partial L}{\partial P'}$
G_A
$1-\frac{\partial L}{\partial P}$
$\lambda(1-\frac{\partial L}{\partial P'})$
$\lambda(1-\frac{\partial L}{\partial P})$
X
$\frac{dF'}{dP'}$
$\frac{dF}{dP}$
$\frac{dF'}{dP'}(\frac{1}{f'})$
$\frac{dF}{dP}(\frac{1}{f})$
INC. FUEL COST f'
INC. FUEL COST f
$\frac{dH'}{dP'}$
$\frac{dH}{dP}$
P'
P
AREA REQT.
TOTAL STATION REQT.
ERROR SIGNAL
λ ADJUSTMENT
λ
G_A DESIRED GEN.
G'_A DESIRED GEN.
G_A REQT.
G'_A REQT.
G_A REGULATOR
G_A BIAS FACTOR
G_A ACTUAL GEN.
G'_A ACTUAL GEN.
G'_A BIAS FACTOR
G'_A REGULATOR
AREA BIAS
FREQ. SCHED.
SYSTEM FREQ.
AREA NET INT. SCHED.
AREA NET INT.
* CONTROL MAY BE MANDATORY OR PERMISSIVE
G_A
G'_A
TIE AB
TIE EA
L_A

Fig. 8. Class III, Type 3 economy dispatch, based on equation 8, and expanded to include incremental transmission loss computation and fuel cost adjustments.

portional action. It is achieved by various combinations of a Class I, Type 3 approach with Class II and Class III controls. Many such arrangements are currently in use.

EQUIPMENT LOCATIONS

FIGS. 2 and 4 to 8, inclusive, do not identify the location of the equipment represented by their several blocks. In practice, some of the control equipment will generally be located at a centralized dispatching office while other portions of the control system will be located at the generating sources. Also, there will be problems related to there being several units, not just one, at each of the stations. Thus, in an actual installation, there will be a host of complexities not shown in the illustrations in this article, but basic concepts will remain as shown in the simplified block diagrams.

CONTROL EXECUTIONS

THE DIAGRAMS in this article show methods of calculating generation change requirements of sources participating in economy dispatch control. These source requirement blocks are shown feeding "regulator" blocks, which in turn are shown as operating on the sources to reduce a corresponding requirement to zero. There are two basic methods of control execution currently in use. They may be termed "permissive" and "mandatory."

The difference between them derives from the fact that there are two levels of error signal which dictate generation change of participating sources. One error signal is at the area level and is the area requirement. The other is at the source level and is the source requirement. The paragraphs that follow describe briefly each of the two types of control execution.

Permissive Control. In this execution, all corrective control action originates from area requirement. Source requirement regulators determine whether or not the prevailing control action from area requirement will or will not be applied to their respective sources. When the area requirement, for example, is for "raise," all sources which have a "raise" requirement are permitted by their respective source regulators to respond to the control signal. Fig. 6 would normally involve such permissive control.

Mandatory Control. In this execution, control action on each source is directly from its own source requirement regulator. Action on each source takes place to restore its own requirement to zero, regardless of the then prevailing nature of area requirement. Figs. 2, 4, 5, 7, and 8 could utilize either permissive or mandatory control.

A postulate to be observed in connection with mandatory executions is that the source requirement computation should include a source-frequency bias factor if the supplementary control is to co-ordinate with source governor responses to remote load changes. If this were not done, mandatory source regulators would oppose the response of governors to remote load changes and would introduce corresponding and unnecessary generation swings on the source. Such source bias factors, though omitted for simplicity from most of the figures, are shown as broken line blocks in Figs. 2 and 8. Source bias factors can indeed be used to impose a definite predetermined frequency–output characteristic on the source which will override the variable characteristic of the governor itself. Some of the more recent mandatory execution installations have included such source bias factors.

More on the Radiant Heat Pump

(This is a brief follow-up on "The Radiant Heat Pump," which appears on p. 118 of the February 1961 issue of *Electrical Engineering*.)

There is, of course, a fallacy in this article. Yet anyone who makes what he thinks is a reasonable sketch is almost certain to hide the truth from himself. Dealing only with the ideal form, Fig. 1(a):

It is true that all 30 watts from the small plate get to the large plate and are absorbed there. It looks as if much more than 30 of the 120 watts from the large plate will get to the small plate. However, this is not true; only 30 watts will get to the small plate.

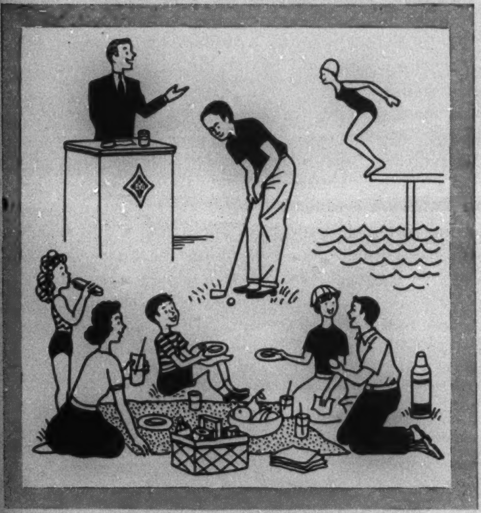
What happens to the other 90 watts from the large plate? They get turned back. If you make a fairly true copy of Fig. 1(a) and start some radiated beams out from the large plate at more angles than I have shown, you will find that a ray bouncing out soon bounces back. It is one of those cases where one's judgment goes woefully off the beam.

As a general truth, if you evacuate a complete enclosure which is lined with perfectly reflecting material, and place any two objects in it at different temperatures, they will trade radiant energy directly and by reflection until they come to the same temperature. When that happens, the net energy change is zero. If the two objects are placed in there at the same temperature, they will remain that way.

A. D. MOORE (F '43)

BACK TO

Summer General Meeting



IMAGINE the ideal place to hold an AIEE Summer General Meeting—plentiful and well-equipped conference halls, nearby rooming accommodations to fit every budget, adequate parking facilities, an atmosphere conducive to technological and scientific discussion, *plus* picturesquely beautiful surroundings with a wide variety of summer recreational activities available.

Sound idyllic? Well, it is—but more than that, it's actually going to happen this year! In a departure from regular practice, AIEE has scheduled this year's Summer Meeting, June 18-23, on the campus of one of America's most beautiful universities—Cornell. Here, in the heart of New York State's fabulous Finger Lakes country, you will be able to combine the regular Institute meeting with a week-long fun-packed vacation. And note this: For less than it would have cost for you alone at the usual resort-hotel meeting, you will be able to bring your family along for the entire week!

Nestled among the rolling hills which overlook Lake Cayuga, Cornell University is a world-renowned seat of learning amid a lovely scenic landscape. The

How long has it been since you've made those trips to class? Relive your college days at AIEE's Summer Meeting at Cornell!

Cornell's extra-high-voltage (345-kv) cable research program will be open to view at the meeting.

Student living quarters, such as in this fraternity house, will provide inexpensive housing for the Summer Meeting.

THE CAMPUS

Ithaca, N. Y., June 18-23

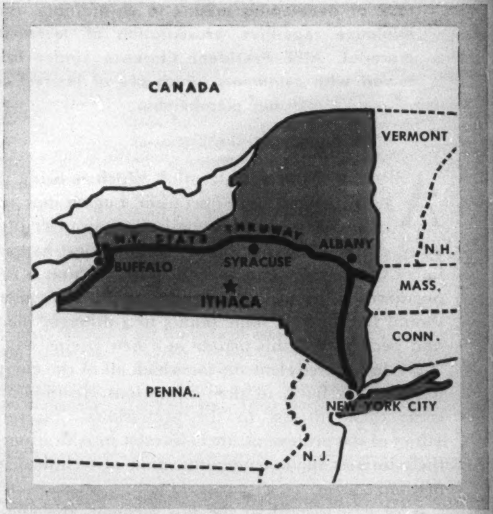
last AIEE general meeting to be held on a college campus took place there 25 years ago.

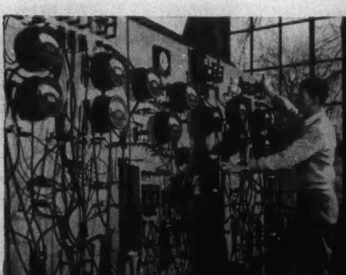
The Cornell campus provides convenient recreational opportunities to satisfy almost every taste. Fine libraries, music rooms, and an art museum complement the laboratories and scientific facilities of a complete university.

For the "athlete," there are tennis courts, an indoor swimming pool, and a championship 18-hole golf course. Walking through the gorges that bound the campus on the north and south should prove delightful to many visitors. In addition, short off-campus trips to such places as Watkins Glen, the Corning Glass Center, Hammondsport Wineries, and Taughannock Falls State Park are being planned.

Housing will be available both on and off campus. Student living quarters on the campus offer economy in price and proximity to meetings. For those who like to "rough it," there are three beautiful State Parks with camping grounds nearby.

You would enjoy motoring to Cornell through the exquisite New York State countryside. Otherwise, the University can be reached by air, rail, or bus.





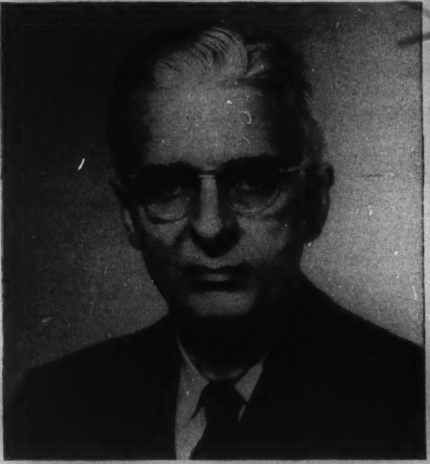
One of Cornell's electrical engineering laboratories. All technical and scientific facilities will be available for inspection.

Phillips Hall, Cornell's E.E. building, will be the scene of much AIEE activity at the Summer Meeting.

Willard Straight Hall, which will serve as headquarters for the AIEE Summer Meeting at Cornell.

INSTITUTE ACTIVITIES

President's Comments



C. H. LINDER
PRESIDENT AIEE

At the Annual General Assembly of the Engineers Joint Council (EJC) on Thursday, January 19, 1961, EJC Vice-President G. E. Holbrook, chairman of the Council's Technical Planning Committee, reported that EJC is preparing to take leadership and urged active support of the member societies in resolving the important task of developing means to co-ordinate and minimize repetitive presentation of technical material. AIEE President Clarence Linder followed with comments which are of interest to our membership.

As one looks at the attention which is being given to the subject of co-operation, I agree that an all-inclusive national organization is probably far away. At the same time, there is a great deal happening today which represents unity in fact, without a formal organization. If you will bear with me a moment, I should like to state some points in a different manner, and perhaps put this matter in a new perspective.

We have three elements for which all of the engineering societies have, in their inception, mentioned concern: their interest in the professional stature and ethics of the profession; their interest in education; and their interest in the communication of technical information.

Now with regard to the first element, the one concerned with ethics and stature of the profession, we have great emotional differences of opinion among ourselves. They stem from wide factual differences in the nature of our employment, the characteristics of the subject matter we deal with, and the end product of our efforts. These differences pose many long-term problems, difficult to resolve.

With regard to the element of education, it is my personal opinion that we have done a thoroughly effective job through ECPD (Engineers Council for Professional Development), the American Society for Engineering Education, and the committees that have represented the various founder societies. There have been very cordial relationships, and much has been accomplished.

It is with regard to the last element, the exchange of technical information, that we seem so terribly inadequate. For example, the only way that one can find out what is going on here in the United States in the area of technical meetings is to refer to a document published by an advertising agency. I do not think this is a very great compliment to the profession, although it may be to the advertising agency, that someone else must tell us who is holding meetings, where, and on what subjects.

We have gone through a great transition. Our present engineering societies were centered around certain focal points which represented major fields of interest 50 to 75 years ago. They tended to be broad, and largely self-contained; for example, electrical engineering, civil engineering, mechanical, and so on. These focal points are no longer relevant to information exchange in the practical sense that they had in the beginning. Today, we are accustomed to proliferating special fields within these older broad focal areas: moreover, a great many of the problems which now face us involve a wide gamut of disciplines, crossing not only the boundaries of fields of interest within a society, but also the boundaries of the societies themselves. In many instances today, a single society which meets to discuss a subject within itself may take it for granted that it is truly talking to itself—bypassing significant areas of competence and experience outside. We could find many instances where it is totally impossible to give adequate consideration to a subject without representation from the disciplines found in many societies.

With the extraordinary growth in the funds of knowledge and understanding in our science and technology, and the proliferation of the kinds of disciplines needed to face important problems, we must have a cohesive force for the exchange of technology. In point of fact,

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C. H. Linder is vice-president and group executive, Electric Utility Group, General Electric Company, New York, N. Y.

some of the new organization growth we call "splintering" has been a process of integration around an information need. There are quite a number of meetings going on around the country now which are integration processes attempting to get the necessary disciplines together to talk about the subjects that are of significant interest to engineers.

We have evidence of this need. AIEE has in the past few years been holding what are called special technical conferences. These technical conferences have been organized around such subjects as the rubber industry or the textile industry, and similar focal points. Here we find that we get twice the attendance per paper that we do in our own general meetings. Why? Because the subject matter is vital, it is important. People rally around it. Many of these meetings have been jointly sponsored; by ASME (American Society of Mechanical Engineers), AIEE, IRE (Institute of Radio Engineers), and other societies.

In my opinion, these partnerships have often been inadequate, because adequate treatment of the subject really required participation by at least half a dozen societies. Many technical meetings—and I am sure that this is true for all societies—do not have the best speakers, the most prominent people, because these people simply cannot be called on to discuss their subjects over and over for the information of one society after another. You cannot attract them unless you get together a group of highly competent people, working in the field, who will really give and take and make the exchange of information profitable.

I appreciate this opportunity to speak about this matter. As I have said before, I am delighted with Mr. Holbrook's comments. I am sure that we in AIEE will be more than pleased to join with the other societies to accomplish appropriate joint meetings. We all have an obligation to ourselves, to industry, to government, and to society for the effective management of technology. I am afraid we are not doing too well; I am sure we must, and can, do better.

AIEE Nominating Committee Selects Officers To Serve During 1961-62

AIEE officers for terms beginning August 1, 1961, were nominated January 30, 1961, by the AIEE Nominating Committee during the Winter General Meeting at the Statler-Hilton Hotel in New York.

For President:

W. H. Chase, vice-president, Ohio Bell Telephone Company, Cleveland, Ohio

For District Vice-Presidents:

T. E. Marburger, assistant general superintendent, Electrical Operations, Baltimore Gas & Electric Company, Baltimore, Md. (District 2)

B. V. Martin, headquarters representative, Westinghouse Electric Corporation, Charlotte, N. C. (District 4)

W. B. Boast, head, electrical engineering department, Iowa State University, Ames, Iowa (District 6)

C. R. Day, electrical engineering supervisor, Sacramento Municipal Utility District, Sacramento, Calif. (District 8)

J. P. Skillen, 44 Paisley Ave., N., Hamilton, Ont., Canada (District 10)

L. J. Weed, head, electrical engineering department, Boston Edison Company, Boston, Mass. (District 12)

A. A. Johnson, engineering manager, Switchgear Division, Westinghouse Electric Corporation, East Pittsburgh, Pa. (District 14)

For Technical Vice-Presidents:

C. E. Dean, radio engineer and editor, Hazeltine Research Corporation, Little Neck, L. I., N. Y. (Communications Division)

L. R. Larson, staff engineer, The Martin Company, Denver, Colo. (General Applications Division)

J. H. Kinghorn, deputy electrical engineer, American Electric Power Service Corporation, New York, N. Y. (Power Division)

For Directors-at-Large:

J. W. Davis, assistant vice-president, operations—engineer, Southern Bell Telephone & Telegraph Company, Atlanta, Ga.

L. C. Holmes, director of engineering operations, Stromberg-Carlson Company Division, General Dynamics Corporation, Rochester, N. Y.

For Department Directors:

Bradley Cozzens, assistant chief electrical engineer, Water & Power Department, City of Los Angeles, Los Angeles, Calif. (General Administration Department)

W. F. Denkhaus, general plant extension engineer, The Bell Telephone Company of Pennsylvania, Pittsburgh, Pa. (Publications Department)

For Treasurer:

W. R. Clark, manager of production engineering, Leeds & Northrup Company, Philadelphia, Pa.

The Nominating Committee, in accordance with the Constitution and Bylaws, consists of one representative of each geographical District, one representative of each Technical Division, and other members chosen by and from the Board of Directors not exceeding in number the number of Technical Divisions.

The Constitution and Bylaws of the Institute require publication in *Electrical Engineering* of the nominations made by the Nominating Committee. Provision is made for independent nominations as indicated in the following excerpts from the Constitution and Bylaws:

Constitution: "C60.020 . . . Additional nominations for any office may be made by written petition of twenty-five or more voting members, in accordance with rules set forth in the Bylaws. For the office of District Vice-President, the petitioners must be from the Districts concerned."

Bylaws: "B60.022. Independent Nominations. Additional nominations for any office may be made in accordance with C26.020. Petitions, proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with C60.020, shall be received by the Executive Secretary not later than March 15 of each year. These nominations shall be included on the ballot if such candidates are eligible."

On the ballot prepared by the Nominating Committee in accordance with the Constitution and sent by the secretary to all qualified voters on or before April 15 of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

A list of members of the Nominating Committee appeared in the February 1961 issue of *Electrical Engineering*, p. 155.

To enable those Institute members not acquainted personally with the nominees to learn something about their engineering careers and their qualifications for the Institute offices to which they have been nominated, brief biographic sketches will be included in a future issue of *Electrical Engineering*.

* * *

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grade, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N.Y.

AIEE Future Meetings

AIEE-IAS-IRE-U of P Engineering Aspects of Magnetohydrodynamics Symposium*
University of Pennsylvania
Philadelphia, Pa.
March 9-10, 1961

AIEE-ASME-II of T American Power Conference*
Sherman Hotel
Chicago, Ill.
March 21-23, 1961

South East District Meeting*
Jung Hotel
New Orleans, La.
April 5-7, 1961

Rubber and Plastics Industries Conference*[1]
Sheraton Hotel
Akron, Ohio
April 10-11, 1961

Materials Handling Conference*[1]
Pick-Congress Hotel
Chicago, Ill.
April 11-12, 1961

Electric Heating Conference*[1]
Sheraton-Lincoln Hotel
Indianapolis, Ind.
April 11-12, 1961

Extra High Voltage Cable Conference*[1]
Mark Twain Hotel
Elmira, N. Y.
April 11-13, 1961

AIEE-AWS Electric Welding Conference*
Commodore Hotel
New York, N. Y.
April 17-21, 1961

Cement Industry Conference*
Sheraton-Cadillac Hotel
Detroit, Mich.
April 18-20, 1961

Great Lakes District Meeting*
Hotel Pick-Nicolett
Minneapolis, Minn.
April 19-21, 1961

AIEE-ASME Railroad Conference
Sir Francis Drake Hotel
San Francisco, Calif.
April 20-21, 1961
This conference has been cancelled.

Joint Rural Electrification and Appliance Conference*
Kentucky Hotel
Louisville, Ky.
May 1-3, 1961

AIEE-IRE-EIA-WCEMA Electronic Components Conference*
Jack Tar Hotel
San Francisco, Calif.
May 2-4, 1961

Spring Textile Conference*
Heart of Atlanta Motel
Atlanta, Ga.
May 4-5, 1961

AIEE-IRE-ACM Western Joint Computer Conference
Ambassador Hotel
Los Angeles, Calif.
May 9-11, 1961
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Mar. 6)

Packaging Industry Conference
New Ocean House
Swampscott, Mass.
May 15-16, 1961
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Mar. 10)

North Eastern District Meeting
Statler Hotel
Hartford, Conn.
May 17-19, 1961
(Final date for †TP—closed, CPMs—Mar. 13)

AIEE-IRE Globe-Communication V Conference[2]
Sherman Hotel
Chicago, Ill.
May 22-24, 1961
(Final date for †TP—closed, ‡CP Syn.—Mar. 8, CPMs—Mar. 17)

AIEE-IRE-ISA-IAS-ARS National Telemetering Conference[2]
Sheraton Towers
Chicago, Ill.
May 22-24, 1961
(Final date for †TP—closed, ‡CP Syn.—Mar. 8, CPMs—Mar. 17)

Fractional Horsepower Motors Conference
Biltmore Hotel
Dayton, Ohio
May 23, 1961
(Final date for †TP—closed, ‡CP Syn.—Mar. 9, CPMs—Mar. 20)

Summer General Meeting
Cornell University
Ithaca, N. Y.
June 18-23, 1961
(Final date for †TP—Mar. 20, ‡CP Syn.—Mar. 30, CPMs—Apr. 14)

Pulp and Paper Conference
University of Western Michigan
Kalamazoo, Mich.
June 21-23, 1961
(Final date for †TP—Mar. 23, ‡CP Syn.—Apr. 7, CPMs—Apr. 17)

Aero-Space Transportation Conference
Benjamin Franklin Hotel
Philadelphia, Pa.
June 26-30, 1961
(Final date for †TP—Mar. 28, ‡CP Syn.—Apr. 12, CPMs—Apr. 21)

AIEE-AIChE-ASME-IRE-ISA Joint Automatic Control Conference
University of Colorado
Boulder, Colo.
June 28-30, 1961
(Final date for †TP—Mar. 30, ‡CP Syn.—Apr. 14, CPMs—Apr. 24)

JETM&B-IFME International Conference on Medical Electronics
Waldorf-Astoria Hotel
New York, N. Y.
July 16-21, 1961
(Final date for †TP—Apr. 18, ‡CP Syn.—May 4, CPMs—May 15)

Pacific General Meeting
Hotel Utah
Salt Lake City, Utah
August 23-25, 1961
(Final date for †TP—May 25, ‡CP Syn.—June 5, CPMs—June 19)

AIEE-IRE-ISA Joint Nuclear Instrumentation Conference
North Carolina State College
Raleigh, N. C.
September 6-8, 1961
(Final date for †TP—June 8, ‡CP Syn.—June 23, CPMs—July 3)

AIEE-ASME Engineering Management Conference
Hotel Roosevelt
New York, N. Y.
September 14-15, 1961
(Final date for †TP—June 16, ‡CP Syn.—June 30, CPMs—July 11)

Petroleum Industry Conference
Jung Hotel
New Orleans, La.
September 17-20, 1961
(Final date for †TP—June 19, ‡CP Syn.—July 5, CPMs—July 14)

AIEE-IRE Industrial Electronics Conference
Boston, Mass.
September 20-21, 1961
(Final date for †TP—June 22, ‡CP Syn.—July 7, CPMs—July 17)

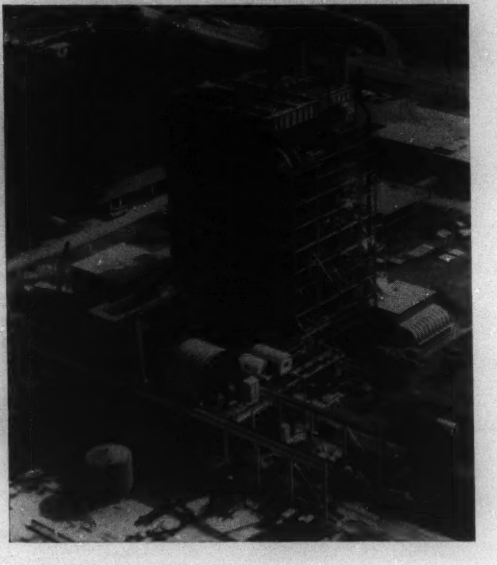
Fall General Meeting
Statler-Hilton Hotel
Detroit, Mich.
October 15-20, 1961
(Final date for †TP—June 14, ‡CP Syn.—July 27, CPMs—Aug. 11)

Winter General Meeting
Hotel Statler
New York, N. Y.
January 28-February 2, 1962
(Final date for †TP—Oct. 30, ‡CP Syn.—Nov. 9, CPMs—Nov. 24)

*Final date for submitting papers—closed
[1] No conflict in subject matter
[2] Planned to coincide

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Transactions and conference papers must conform to the requirements in *Author's Guide*. For a copy, write to E. C. Day, 33 W. 39th St., New York 18, N. Y.



LOUISIANA Power and Light Company's Little Gypsy Steam Electric Station will be visited April 7 during the Joint District Meeting of South East District 4 and South Central District 13. This is an aerial view of the 230,000-kw generating station, named for the plantation which it occupies in part. Located a short distance up the river from New Orleans, the station is the first completely automated plant to be built in the world and is capable of computer controlled start-up and shut-down operation.

Industrial Aerial Photo

AIEE Districts 4 and 13 Schedule Joint Meeting for April 5-7 in New Orleans

NEW ORLEANS, La., will play host to South East District 4 and South Central District 13 for their joint meeting on April 5-7 at the Jung Hotel.

The technical sessions will cover the latest developments in many fields of interest to AIEE members. The program encompasses the application of electricity in medicine, power and communications, industry, shipbuilding, and missiles. Along with engineering education, of strong regional interest is one session devoted to geophysical exploration.

Social Events

Visitors have always enjoyed New Orleans' "Old World Charm" and world-renowned cuisine.

A "Welcome to New Orleans" luncheon will be held Wednesday at 11:30 a.m. This function for both delegates and their ladies will officially open the meeting. The feature of the program will be a talk by "Pie" Dufour, New Orleans author, whose "A la mode" column appears daily in the *New Orleans States—Item.*

The "Hospitality Party" will take place Wednesday at 5:30 p.m. This event for delegates and their ladies will provide a springboard for a night "out on your own" with an opportunity to enjoy internationally famous cuisine at any of the many of New Orleans' renowned restaurants. Entertainment during the cocktail hour will be provided by a Dixieland group.

On Thursday at 6:30 p.m., the "Refreshment Hour and Dinner Dance" will take place. Delegates and their ladies are invited to enjoy an evening of fun, dining, and dancing.

Ladies Program

The "See New Orleans" tour on Wednesday at 2:00 p.m., led by professional guides, is designed to show how a dynamic city such as New Orleans has been able to meld the past with the present. It will include a visit to civic, residential, and educational areas.

"Breakfast at Brennan's" on Thursday at 10:00 a.m., will introduce a never-to-be-forgotten breakfast in true New Orleans style.

The "Tour of Vieux Carre" will be held on Thursday at 1:00 p.m. This walking tour has been planned in order to view a section of the city which is truly old world transplanted to the new. Historic French and Spanish architecture will be seen, along with quaint patios, antique shops, and many French Quarter restaurants.

At the special ladies meeting on Friday at 10:30 a.m., J. G. Adams will present an illustrated lecture on "The Total Electric Home."

A room has been reserved for morning and afternoon coffee for the ladies. Bridge tables and cards will be available. Members of the Ladies Activities Committee will be present throughout the day to welcome and assist visiting ladies.

Inspection tours will be made to the following places:

Wednesday, April 5 (2:00 p.m.) Avondale Shipyards.

Thursday, April 6 (9:00 a.m.) American Sugar Refineries.

Thursday, April 6 (1:30 p.m.) Harbor Tour, Yacht "Good Neighbor." Celotex Corporation.

Friday, April 7 (9:00 a.m.) Kaiser Aluminum and Chemical Corporation, Chalmette Plant.

Friday, April 7 (9:00 a.m.) New Orleans Sewerage and Water Board.

Friday, April 7 (2:00 p.m.) Little Gypsy Steam Electric Station, Louisiana Power and Light Company.

Friday, April 7 (2:00 p.m.) Jackson Brewery.

Members of the Joint District Meeting Committee in charge of arrangements are: Chairman—J. R. Rombach; Vice-Chairman and Ladies' Activities—J. C. Ryan; Secretary—S. Cambias, Jr.; Assistant Secretary—M. L. Hurstell, and Treasurer—E. I. Blanchard. Committee chairmen are as follows: Program—J. A. Cronvich; Finance—B. P. Babin; Registration—P. A. Dimberg; Entertainment—C. F. Dunn; Hotels—G. H. Kellermann; Inspection Trips—H. A. Schaeffer, Jr.; Publicity—R. J. Meyer, and Student—G. W. Webb.

The tentative technical program for the joint meeting follows:

Wednesday, April 5

1:30 p.m. Student Papers Competition

Chairman: Chief judge of student papers, District 4.

2:00 p.m. Sessions

System Engineering and Planning

Chairman: Jack Davey, Louisiana Power & Light Co.

Higher Secondary Utilization Voltages. *A. L. Baxter,* Allis-Chalmers Mfg. Co.

CP61-492. Digital Computer Analysis of a Radial Power System. *G. A. Mathews, J. M. Barber, J. C. McKee, Jr.,* Mississippi State Univ.

Voltage Regulation on Urban Systems. *E. J. Kleine,* Allis-Chalmers Mfg. Co.

The Methods and Policy of Voltage Control on Louisiana Power & Light Co. System. *H. L. Deloney,* Louisiana Power & Light Co.

Missiles

Chairman: H. I. Madden, Bedell & Nelson Engineers, Inc.

A Communications Engineer Looks at Conical Scanning for Missile Tracking. *Frank Coxe,* Space Technology Labs, Inc.

Automated Testing of the Tracking Capabilities of Missile Ground Guidance Equipment. *T. G. North, J. B. Casey, J. B. Crouch, J. L. Collins,* Western Elec. Co.

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The State of the Art of Electro-Magnetic Signal Attenuation in Ionized Planes. *Horst Poehler*, Space Technology Labs.

Geophysical Exploration

Chairman: W. D. Stroud, Okonite Co.

Electronic Surveying in Offshore Areas. *Joseph De Lerno, Jr.*, Offshore Navigation, Inc.

Environmental Problems of Electrical Components in Well-Logging. *A. C. Skellie*, Schlumberger Well Surveying Corp.

Semiconductor vs. Conventional Design in Seismic Amplifiers and Effects on Performance. *Fred Hefer*, Dresser Electronics

Communications

Chairman: F. C. Hollins, American Telephone & Telegraph Co.

CP. Recent Developments in Digital Feedback Communication System. *L. S. Schwartz*, New York Univ. Discussion. G. D. Framton

CP. Microwave Communication in the Gulf of Mexico. *E. B. Stevenson*, Continental Pipe Line Co.

CP. The Telephone Concentrator for Central Office Service Extension. *R. C. Hingle*, Southern Bell Telephone & Telegraph Co.

CP61-211. Administration of Exchange Area Trunks for Good Transmission. *J. D. Howard, Jr.*, Southern Bell Telephone & Telegraph Co.

Thursday, April 6

8:30 a.m. Student Papers Competition

Chairman: Chief judge of student papers, District 13.

9:00 a.m. Sessions

Industrial Application I

Chairman: M. G. Myers, Westinghouse Elec. Corp.

CP. The Application of Digital Computers to Industrial Process Control Problems. *R. S. Gillette*, General Elec. Co.

CP. A Supervisory Control and Telemetering Installation in an Industrial Plant. *H. O. Borque*, Ethyl Corp.

CP. Surge Protection for Industrial Plants. *J. R. Pope*, Westinghouse Elec. Corp.

CP. The Conversion of Existing Industrial Power Systems from Ungrounded Neutral to Grounded Neutral. *H. B. Greear*, General Elec. Co.

Transmission and Distribution

Chairman: F. E. Johnson, Jr., New Orleans Public Service Inc.

CP61-488. The Lightning Stroke—II. *C. F. Wagner, A. R. Hileman*, Westinghouse Elec. Corp.

CP61-489. Mechanism of Breakdown of Laboratory Gaps. *C. F. Wagner, A. R. Hileman*, Westinghouse Elec. Corp.

A Progress Report on Incipient Fault Detection on Cables. *H. J. Edwards, Jr.*, New Orleans Public Service Inc.

Lightning Protection of River Crossings. *E. J. Allen*, General Elec. Co.; *H. L. Deloney*, Louisiana Power & Light Co.

Shipbuilding

Chairman: E. E. Leonard, Jr., Avondale Shipyards, Inc.

Some Aspects of Automation for Ships. *S. A. Haverstick*, Westinghouse Elec. Corp.

Electrical Instrumentation of Marine Propulsion Plants. *A. K. Smith*, Ingalls Shipbuilding Corp.

Concepts in the Versatility of Marine Electrical Systems. *R. S. Berney*, Alabama Drydocks and Shipbuilding Co.

Commercial and Residential Applications

Chairman: G. S. Schroeder, Schroeder & Associates

The Electrical Supply System for the New Electrical Engineering Building at Louisiana State University. *L. V. McLean, A. K. Ramsey*, Louisiana State Univ.

Correcting the Inadequacies of Residential Service Entrance Facilities. *C. B. Grund, Jr.*, Southern Services, Inc.

Application Trends, Commercial and Residential. *M. G. Zervigon*, Zervigon Associates, Inc.

Electric Heating for Home and Office. *E. E. Parks*, Nashville Elec. Service.

2:00 p.m. Sessions

Instrumentation

Chairman: J. A. Loupe, Jr., Kaiser Aluminum & Chemical Corp.

CP. The Gyro Integrating Moss Flowmeter. *F. P. Singletary*, General Elec. Co.

CP. Measurement of Large Direct Currents in Electrolytic Processes by Methods of the A-C/D-C Metering System. *C. H. Elliot, H. F. Morvant*, Kaiser Aluminum & Chemical Corp.

CP. Automatic Lease Monitor and Control Systems. *O. E. Potthoff*, General Elec. Co.

CP61-490. Analysis of Measuring Circuits for Radio Influence Voltages. *P. B. Jacob, Jr., F. O. Simons, Jr.*, Mississippi State Univ.

Substations and Switchgear

Chairman: M. W. Stumpf, New Orleans Public Service Inc.

- The Role of Grounding Cells in the Effective Cathodic Protection of Lead Sheathed Power Cables in Substation Exit Systems. *S. E. Trouard, M. J. Maier*, New Orleans Public Service, Inc.

Points for Consideration in Selecting Transmission Line and Substation BIL. *R. L. Lindsey, H. H. Strozier*, Georgia Power Co.

Proposed New Breaker Ratings and their Effect on Applications. *A. H. Knable*, Allis-Chalmers Mfg. Co.

Industrial Application II

Chairman: H. O. Bourque, Ethyl Corp.

CP. Automatic Controls for Gas Transmission Systems, *D. C. Washburn*, Westinghouse Elec. Corp.

CP. Testing High-Voltage Cables with Direct Current. *J. C. Pittman*, Fortier Plant American Cyanamid

CP. A New Look at Acyclic Generation. *J. R. Burnett, L. M. Harvey*, General Elec. Co.

CP. A Practical Low Voltage Multiple System for Landing Field Lighting. *R. M. Garth*, U.S. Navy

Education

Chairman: J. C. McKee, Jr., Mississippi State Univ.

The Engineering Profession's Stake in Technical Institute Education. *A. R. Sims*, Univ. of Houston

The Undergraduate Curricular Revolution. *C. R. Vail*, Duke Univ.

Engineering Science, A Philosophy. *Karl Brenkert, Jr.*, Auburn Univ.

The Relation of the Engineering Ph. D. to the Future Development of the South. *T. F. Jones, Jr.*, Purdue Univ.

Engineering Training in the Communications Industry. *K. G. Walters*, Western Elec.

Friday, April 7

9:00 a.m. Sessions

Electricity in Medicine

Chairman: C. J. Sperry, Jr., Tulane Univ.

Electrical Instrumentation in Medicine. *H. E. Hoff, L. A. Geddes*, Baylor Univ.

Recent Advances in the Square-Wave Electromagnetic Flowmeter. *E. J. Dennard*, Western Elec. Co.

The Electrical Nature of Brain Activity. *L. M. N. Bach*, Tulane Univ.

A Single-Channel Miniaturized FM Transmitter for Remote Recording of Subcortical Potentials. *C. J. Sperry, Jr., C. P. Gadsden*, Tulane Univ.

Power Generation

Chairman: C. P. Almon, Jr., TVA

The Energy Storage Type of Peaking Capacity. *Arnold Rich*, Federal Power Commission

CP61-491. Station Service Design Considerations for 650-Mw units at TVA Paradise Steam Plant. *B. M. Maxwell, L. R. Sellers*, TVA

Computer Control at Little Gypsy Generating Station. *W. T. Hess*, Louisiana Power & Light Co.

Southwestern Electric Power Co.'s Automatic Dispatching System. *W. J. Googe*, Southwestern Elec. Power Co.; *E. D. Crane*, Westinghouse Elec. Corp.

Power System Communications and Relays

Chairman: W. J. Wortman, Duke Power Co.

New Concepts in Molecular Electronics. *S. J. Angello*, Westinghouse Elec. Corp.

New Digital Telemetering Equipment to Share Analog Channel. *P. B. Robinson*, General Elec. Co.

A Review of New Orleans Public Service Inc. Back-up Relaying Practice. *A. J. Bartlett*, New Orleans Public Service Inc.

A New Approach to Loss of Field Protection and Stability of Generating Units. *Jack Davey*, Louisiana Power & Light Co.

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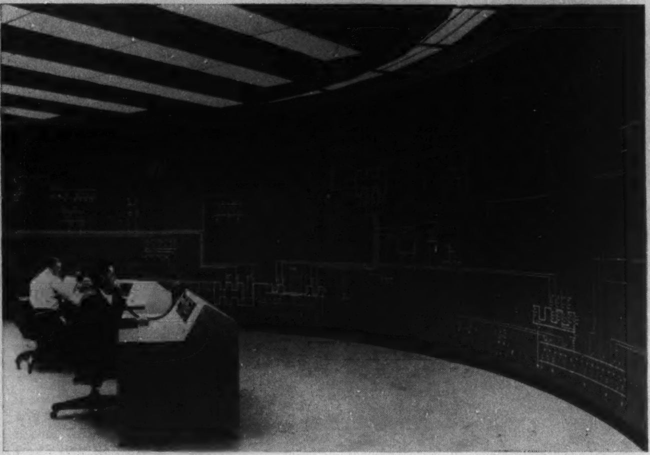
The accumulated engineering literature of 1960 is now being compiled for dissemination on a world-wide basis in *The Engineering Index* bound volume for 1960. A request will bring you without charge the current catalog. Address: *The Engineering Index*, 29 W. 39th St., New York, 18, N. Y.



Connecticut Light & Power Co.

THIS 68-foot long diagram board is the heart of the Connecticut Light and Power Company's underground electric power dispatching center at Southington. The center was located underground to provide protection in the event of radioactive fallout. Using electronic computers, load dispatchers direct transmission line operation and switching from the room shown in the picture. The dispatch center will be toured during the North Eastern District Meeting.

North Eastern District Meeting Scheduled May 17-19 in Hartford, Conn.

HARTFORD, CONN., surrounded by industries of the space age, electronics, computers, rocketry, and jets, forms the background for the AIEE North Eastern District meeting which will be held May 17-19, 1961, at the Hotel Statler.

Advances which only electricity makes possible will be marked by papers on timely subjects. Highlighting far horizons of the future, the program will include subjects of current interest by speakers who are specialists in their fields. "Electricity—Creator of Horizons Unlimited" will be the theme of the meeting.

Technical Program Planned

The requirements of miniaturization and instrumentation brought about by the efforts to conquer space will be presented, along with subjects on computers, powercasting, and the solution of low-voltage network problems by digital methods.

Numerous papers on industrial control, ranging from Thyratron motor control through industrial digital regulators, numerical contouring controls, digital numerical machine tool controls, and stepping motors will be heard.

Communications will have a prominent spot on the program covering the latest in "touch tone" dialing, centralized answering services, selective calling, personal signaling service, data communications, microwave radio developments, and many others.

New power generation ideas will be presented on the program with discussions of peaking units, fuel cells, direct conversion of energy, general energy conversion, pumped storage, and the economics of hydro design.

Power system engineering, distribution, and transmission with their corresponding relaying subjects will also occupy a large part of the program. The much discussed EHV project will be a part of this section's material.

Industrial power will have speakers for various industries on continuous furnace annealing, case hardening, and high-frequency resistance heating.

The intense interest in electric space heating will be reflected in several papers on latest developments in information on requirements, not only for the buildings to be heated, but also for the distribution system required to supply them.

Inspection tours will be made to plants and locations related to the program subjects.

Dinner Dance Highlighted

The highlight of the social activities will be the dinner dance on Thursday, which more than 400 people are expected to attend.

Student activities will take the form of a contest, with opportunity for presentation of the winning papers at the meeting. Student members will be guests of the district organization at a breakfast to be held on Friday.

At the District vice-president's luncheon, when the awards will be presented, student members will be the guests with their counselors of the Connecticut Section.

The meeting committee is composed of the following: C. T. Hughes, chairman; C. L. Derrick, vice-chairman, and J. M. Schamberger, secretary. Committee chairmen include: A. E. Sapega, registration; J. D. C. Guy, Jr., entertainment; R. W. Boyd, inspection trips; Theodore Newcomb, transportation; M. E. C. Devine, hotel arrangements; D. C. Switzer, technical program; H. M. Marsden, student activities; Mrs. L. B. Grew and Mrs. J. D. C. Guy, Jr., ladies' activities; and E. A. Johnson, finance.

Call to Authors Issued for Papers on Quality Control

A call to authors has been issued for technical papers to be presented at the 8th National Symposium on Reliability and Quality Control, scheduled January 9-11, 1962, at the Statler Hilton Hotel, Washington, D. C.

Sponsoring the conference are: AIEE, the Institute of Radio Engineers, and the American Society for Quality Control.

The time table of the Program Committee is as follows:

May 15, 1961, is the deadline for the submission of the title of a paper and an abstract of not more than 800 words. The letters and spaces in the title for the program must not exceed 50. Brief biographical sketches of the author or authors, suitable for publication in the *Proceedings*, should be submitted. For papers with more than one author, a single author should be indicated for the presentation.

Ten copies of the abstract and biographies should be sent to: E. F. Jahr, IBM Corporation, Department 351, Owego, N. Y.

On June 30, 1961, authors will be notified of the paper acceptance or rejection.

The complete paper must be submitted to the Program Committee on October 6, 1961, for publication in the Symposium *Proceedings*.

All papers must be new and not presented prior to the symposium at a national society meeting. Papers presented at local meetings are acceptable.

Availability of Zener Diodes To Be Studied by Subcommittee

The availability of zener diodes of surprisingly stable breakdown voltage characteristics prompts the question—"What are the design parameters of the ideal diode device that can serve as a voltage standard?"

Under the chairmanship of F. R. Kotter of the National Bureau of Standards, a subcommittee of the Recording and Controlling Instrumentation Committee has been formed to study zener diodes and other current and voltage reference devices as they are required in recording and controlling instrumentation.

Inquiries in regard to this project should be directed to: F. R. Kotter, National Bureau of Standards, Washington 25, D. C.

Great Lakes District Meeting Planned

Anthony Lane

ARRANGEMENTS for the AIEE Great Lakes District Meeting to be held April 19-21 in Minneapolis, Minn., are being made by the Minnesota Section. Members of the committee in charge of arrangements are: *(front row, left to right)* D. C. Peterson, S. N. Witts, E. A. Willson (chairman), Jim Fortchner (vice-chairman), and C. A. Fagrelius, and *(back row, left to right)* J. E. Holte, G. W. Alexander, L. A. Helling, C. F. Healey, H. N. Sommer, R. G. Wiprud, and L. W. Christensen. The program chairman is Mr. Witts. Speakers will include AIEE President Clarence Linder and Dr. John Kelley of the Westinghouse research department. Mr. Alexander has listed a group of inspection trips in the Twin City areas.

Conference on Electric Heating To Be Held April 11-12 in Indianapolis

THE 5th Biennial AIEE Conference on Electric Heating will be held April 11-12 at the Sheraton-Lincoln Hotel in Indianapolis, Ind.

Sponsored by the Electric Heating Committee, with the AIEE Central Indiana Section as host, this will be a conference for users, practical rather than theoretical, and will cover process heating equipment and applications for industry. A bound volume of the papers presented will be distributed and is included in the registration fee.

Fifteen informative papers presented by authorities in their fields and aimed at the man in the shop as well as the engineer will be presented, with question and answer periods for each.

Everyone with an interest in industrial heating is invited to attend—AIEE membership is *not* required. Programs and registration cards may be obtained from W. T. Duhm, Indianapolis Power and Light Company, P. O. Box 1595, Indianapolis 6, Ind.

A tentative technical program of the conference follows:

Tuesday, April 11

8:00 a.m. Registration

9:30 a.m. Welcome

Presiding: C. A. Tudbury, chairman, AIEE Electric Heating Committee

Welcome: F. S. English, Cory, Crum & English, chairman, Central Indiana Section AIEE

Electric Heat's Future in Industry. *Frank Flick,* Flick Reedy Corp.

9:50 a.m. First Session

Chairman: K. J. Sorace, Lamson & Sessions Co.

Selection and Control of Equipment for Heating Air and Other Gases for Process Work and Environmental Testing. *M. Epstein,* Industrial Engineering & Equipment Co.

Bright Annealing of Stainless Steel. *L. W. Johnson,* General Elec. Co.

Controls Incorporated—Always. *A. B. Conant,* Couchman-Conant, Inc.

12:00 Noon Luncheon

1:30 p.m. Second Session

Chairman: W. T. Thomas, Project Matterhorn, James Forrestal Research Center, Princeton Univ.

Application of Radio Frequency Generators to Induction Heating. *R. A. Sommer, G. A. Kappenhagen,* Ohio Crankshaft Co.

Induction Melting Equipment and Applications. *R. S. Segsworth,* Ajax-Magnethermic Corp.

Construction, Operation, and Maintenance of Modern High-Frequency Alternators. *P. S. Tsivitse,* Reliance Elec. and Engineering Co.; *R. J. Kasper,* Ohio Crankshaft Co.

Induction Heating Controlled by Average Billet Temperature. *Vernon Pieron,* Ajax-Magnethermic Corp.

7:00 p.m. Banquet

8:00 p.m. Evening Session

Presiding: C. A. Tudbury, chairman, AIEE Electric Heating Committee

Wednesday, April 12

9:30 a.m. Third Session

Chairman: J. R. Wark, Indianapolis Power and Light Co.

The Challenge of Electric Heat. *W. T. Richards,* Indianapolis Power and Light Co.

Electric Floor Panel Heating. *L. E. Whitehead,* Commonwealth Edison Co.

High-Temperature Radiant Sources. *J. P. Frier,* General Elec. Co.

Radiant Heating for Coal Car Thawing. *D. A. Aitken,* Aitken Products, Inc.

1:30 p.m. Fourth Session

Chairman: J. E. Friess, General Elec. Co.

Fluidized Bed Heating. *B. A. Ruediger,* General Elec. Co.

Changes in the FCC Regulations for Radio Frequency Induction and Dielectric Heating Equipment. *W. H. Hickok,* Chematron Corp.

Electric Heating in Research. *A. F. Leatherman,* Battelle Memorial Institute

Low Distortion Hardening of Automotive Axles by Induction Heating. *J. W. Peach,* Westinghouse Elec. Corp.

Banquet and Luncheons

There will be a banquet Tuesday, April 11, at 7:00 p.m. Tickets are $5 each, which includes gratuities. Payment for this should be included with the registration fee.

There will be luncheon accommodations available in the Lincoln and Travertine Rooms. Tickets for luncheon will be available at the conference at $2.50 each, which includes gratuities.

Operating Committees

Conducting the conference are the following committees and their chairmen:

Conference Steering: Chairman—K. J. Sorace, Lamson and Sessions Co.

Program: Chairman—W. T. Thomas, James Forrestal Research Center

Publicity: Chairman—J. E. Friess, General Elec. Co.

Treasurer: C. S. Strickland, Indianapolis Power & Light Co.

Registration: Lee Sickle, Indianapolis Power & Light Co.

Local Arrangements: J. R. Wark, Indianapolis Power & Light Co.

AIEE Headquarters Representative: R. S. Gardner, 33 W. 39 St., New York 18, N. Y.

Telemetering Conference To Discuss Science and Education

The National Telemetering Conference will be held May 22-24 at the Sheraton Towers Hotel, Chicago, Ill.

"Science and Education in Telemetry" will be the conference theme.

The conference is sponsored jointly by five technical societies: AIEE, the American Rocket Society, the Institute of Radio Engineers, the Institute of the Aerospace Sciences, and the Instrument Society of America.

AN aerial view is shown of the Cornell EHV Cable Testing Station at Ithaca, N. Y., which will be inspected during the AIEE EHV Cable Conference on April 13 at Cornell University.

EHV Cable Conference To Be Held April 11-13 at Elmira and Cornell University

THE AIEE Extra-High-Voltage (EHV) Cable Conference, to be held April 11-13, will feature sessions on the European practice of the testing of cables, the Association of Edison Illuminating Companies (AEIC)–Edison Electric Institute (EEI)–Manufacturers EHV Research Project, and an inspection trip to the Cornell Test Site. The conference will take place at the Mark Twain Hotel in Elmira, N. Y., on April 11-12 and at Cornell University in Ithaca, N. Y., on April 13.

Preceding the conference, the Insulated Power Cable Engineers Association (IPCEA) will act as host at dinner on Monday evening, April 10, to the European visitors and their wives who will attend the 3-day meeting. G. J. Crowdes, president of IPCEA, is in charge of arrangements for the dinner.

The tentative technical program for the conference follows:

Tuesday, April 11

Morning Session—European Practice of Testing of Cables

Central Testing Laboratories of KEMA, Arnhem, The Netherlands. *J. C. Van Staveren*

Staythorpe Testing Station of the Central Electricity Generating Board of Great Britain. *C. C. Barnes*, CEGB

Fontenay Testing Station of Electricite de France. *R. Tellier*, Electricite de France

Discussion period

AEIC-EEI-Manufacturers EHV Cable Research Project

Afternoon Session

Introduction: C. T. Hatcher, Consolidated Edison Co. of New York

1. Testing Station—Underground System. *L. I. Komives*, Detroit Edison Co.
2. Testing Station—Equipment and Design. *C. S. Schifreen, A. D. Bertolett*, Phila. Elec. Co.
3. Testing Technique. *J. L. Rosson*, Cornell Univ.

Discussion period

Wednesday, April 12

Morning Session

4. Pothead A—Low-Pressure, Oil Filled, Non-Graded. *E. D. Eich, L. C. Ebel, E. O. Juhlin*, Anaconda Wire & Cable Co.
5. Pothead B—High-Pressure, Oil-filled, Capacitor-Graded. *J. F. Brandt*, Ohio Brass Co.
6. Pothead C—High-Pressure, Oil-filled, Capacitor-Graded. *G. E. Lusk, J. H. Nicholas, R. T. Papp*, G & W Specialty Co.

Discussion period

Afternoon Session

7. Cable No. 1—High-Pressure, Oil-filled Pipe Type. *R. C. Waldron, R. B. Blodgett*, Okonite Co.
8. Cable No. 2—High-Pressure, Oil-filled, Pipe Type. *L. Meyerhoff, M. H. McGrath, J. Bower*, General Cable Corp.
9. Cable No. 3—High-Pressure, Oil-filled, Self-Contained Type. *E. J. Merrell, A. L. McKean*, Phelps Dodge Copper Products Corp.
10. Cable No. 4—Low-Pressure, Oil-filled Self-Contained Type. *E. D. Eich, L. C. Ebel, S. Ege*, Anaconda Wire & Cable Co.

Discussion period

Thursday, April 13

Morning Session

Inspection trip to Cornell EHV Cable Testing Station. *J. L. Rosson*, Cornell Univ.

Afternoon Session

General discussion period

Technical Papers Sought for Presentation at Symposium

A call for papers has been issued by the AIEE Computing Devices Committee for presentation at the 2nd Annual Symposium on Switching Circuit Theory and Logical Design which will take place during the 1961 Fall General Meeting in Detroit, Mich., on October 15-20. The symposium is being sponsored by the Subcommittee on Logic and Switching Circuit Theory.

Prospective authors are invited to submit papers on significant work in switching circuit theory and logical design of digital systems. Papers are desired having theoretical or practical interest and describing new work in all areas of switching theory and logical design that include, for example:

1. Threshold logic.
2. Neural nets.
3. Multivalued logics.
4. Design algorithms.
5. Practical logical design aids.
6. Design of reliable automata.
7. Application of graph theory to switching circuits.
8. Logical design for intelligent machines.
9. Application of Boolean matrices to switching circuits, etc.

An innovation of the 1961 symposium will be the availability of its published proceedings in advance of the meeting. In order that abstracts and papers of the prospective authors are available early enough for selection, preparation of the program, and printing, strict adherence to the following schedule is essential.

> April 10: Deadline for receipt, in quadruplicate, of a 100- to 200-word abstract and a 500-word summary of the paper. To assure full consideration, submit as early as possible.
> May 1: Notification of paper selection and request for complete papers.
> July 17: Deadline for receipt of full-length symposium papers according to AIEE rules.

All correspondence related to the 1961 symposium should be addressed to the symposium chairman: D. R. S. Ledley, National Biomedical Research Foundation, 8600 16th St., Silver Spring, Md.

Protective Devices Committee To Hold Open Forum on April 5

The Protective Devices Committee of the AIEE Power Division will hold an open forum on "Switching Surge Duty on Lightning Arresters" on April 5 at the Netherland-Hilton Hotel in Cincinnati, Ohio.

All interested persons are welcome to attend the forum and the committee meeting the following day, April 6. G. D. Breuer, secretary for the Protective Devices Committee, General Electric Company, Schenectady, N. Y., may be contacted for details of the program.

American Power Conference Schedules Annual Meeting for March 21-23 in Chicago

SESSIONS devoted to the creation of energy through nuclear fission will be featured at the 23rd annual meeting of the American Power Conference (APC), which will be held March 21-23 at the Sherman Hotel in Chicago, Ill.

More than 100 technical papers will be presented during 31 sessions.

The conference will include discussions concerning the supercritical electric power stations, the Breed Station of the American Electric Power Company, and the Avon Station of the Cleveland Electric Illumination Company. These stations employ steam of very high pressure and temperature in order to secure maximum efficiency. Other sessions will be devoted to the future of nuclear energy and the most promising methods of generating power from nuclear fission.

About 3,000 industrial and electric utility executives, engineers, educators, and government officials are expected to attend the conference.

R. A. Budenholzer is directing the conference for the Illinois Institute of Technology, and E. R. Whitehead is the secretary.

Co-operating societies include: AIEE; American Institute of Chemical Engineers; American Institute of Mining, Metallurgical, and Petroleum Engineers; American Society of Civil Engineers; American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE); American Society of Mechanical Engineers (ASME); National Association of Power Engineers (NAPE); Western Society of Engineers (WSE), and Engineers' Society of Milwaukee.

Co-operating universities are: Iowa State, Michigan State, Northwestern, Purdue, State University of Iowa, and the Universities of Illinois, Michigan, Minnesota, and Wisconsin.

Regional associated universities are the following: Agricultural and Mechanical College of Texas, California Institute of Technology, Georgia Institute of Technology, Massachusetts Institute of Technology, and New York University.

The tentative program for the 1961 meeting follows:

Tuesday, March 21

8:30 a.m. Registration

9:30 a.m. Opening Meeting

Invocation.

W. F. Crawford, president, Edward Valves Inc., and president, Republic Flow Meters Co., subsidiaries of Rockwell Manufacturing Co., Chicago, Ill., will speak on "Our Changing Perspectives."

11:30 a.m. Sponsored Student Tour

(Limited to Sponsored Students and Professors)

A tour of the Dresden Nuclear Power Station of Commonwealth Edison Company has been arranged for the group of students and professors sponsored by the utility industry. Buses will leave from the Sherman Hotel immediately following the Opening Meeting.

Program at Dresden Station

a. Welcoming Remarks. Harlan Hoyt, superintendent of Dresden Station.

b. Operation of the Dresden Nuclear Power Station. B. B. Stephenson, engineer, Dresden Station.

c. Tour of Station.

12:15 p.m. Joint APC-ASME Luncheon

Sponsored by ASME

Chairman: W. H. Byrne, president, ASME

Co-Chairman: E. J. Carraro, chairman, Chicago Section ASME

Speaker: Sherman Knapp, president, Edison Electric Institute

2:00 p.m. Central Stations I—Avon No. 8 —A Supercritical Plant

Sponsored by the Power Division of ASME

Chairman: J. H. Harlow, chief mechanical engineer, Phila. Elec. Co.

Co-Chairman: H. L. Solberg, associate dean of engineering, Purdue Univ.

Initial Operation of Avon No. 8—A Supercritical Plant. *N. F. Gill*, Cleveland Elec. Illum. Co.

Supercritical Boiler Operating Experiences at Avon No. 8. *J. I. Argersinger, G. C. Smith*, Combustion Engineering, Inc.

Avon Superpressure Steam Turbine—Generator Unit. *C. C. Franck, Sr., J. A. Carlson*, Steam Division, Lester, Pa.

2:00 p.m. High-Voltage Transmission

Sponsored by the Power Division of AIEE

Chairman: W. A. Lewis, AIEE director, research professor of electrical engineering, Illinois Institute of Technology.

Co-Chairman: G. S. Reeder, chairman, Power Section, Chicago Section, AIEE, Commonwealth Edison Co.

Switching Surges Due to Energization or Reclosing. *I. B. Johnson, D. D. Wilson, R. F. Silva*, General Elec. Co.

Investigations on Wood Pole 345-kv Test Line. *T. W. Schroeder*, Illinois Power Co.; *J. E. O'Neil*, Westinghouse Elec. Corp.

A Theory Regarding the Generation of Radio Noise of High-Voltage Transmission Lines. *S. B. Griscom*, Westinghouse Elec. Corp.

Radio Interference Design Factors for EHV Lines. *R. J. Mather, E. H. Gehrig*, Bonneville Power Admin.

2:00 p.m. Industrial I—Space Air Conditioning

Sponsored by ASHRAE

Chairman: G. F. Carlson, Bell & Gossett Co.

Co-Chairman: W. V. Richards, president, Illinois Chapter, ASHRAE, H. A. Phillips & Co.

Off Peak Electricity Using Stored Water for Space Heating. *S. B. Tupper*, Bell & Gossett Co.; *R. J. Vertovec*, Commonwealth Edison Co.

A New Approach to Heat Pumps. *G. M. Warren*, Carrier Air Conditioning Co.

Thermoelectric Heating and Cooling Devices. *J. D. Richards*, Minnesota Mining & Mfg. Co.

High-Temperature High-Pressure Hot Water Heating. *D. L. Lindsay*, Wiggs, Walford, Frost & Lindsay.

2:00 p.m. Industrial II—Electrical

Sponsored by Industrial Group, Chicago Section, AIEE.

Chairman: W. H. Cook, chairman, Industrial Group, Chicago Section, AIEE, Western Elec. Co.

Co-Chairman: J. N. Banky, Allis-Chalmers Mfg. Co.

Application and Operation of an 11,000-hp Motor in a Petroleum Refinery. *K. R. Sheetz*, American Oil Co.

Factors to Consider in the Selection of Diesel Electric Generators for Emergency Power. *E. A. Gibbons*, Allis-Chalmers Mfg. Co.

Time for More Talk and Less Action. *W. J. Neiswander*, Western Elec. Co., Inc.

2:00 p.m. Water Technology I—High Purity Water

Chairman: M. D. Baker, West Penn Power Co.

Co-Chairman: G. A. Hellman, Michigan College of Mining & Technology

Effective De-aeration in Surface Condensers—Recent Experiences. *P. J. Hamm*, C. H. Wheeler Mfg. Co.

A New Method for Increasing Sensitivity of Conductivity Measurement of Steam Purity. *R. W. Lane, C. H. Neff, T. F. Larson*, Illinois State Water Survey

Application Considerations—Demineralization and Flash Evaporation. *M. E. Gilwood*, Ionac Chemical Co.; *J. Mack*, Permutit Co.

8:00 p.m. Evening Forum—Future Sources of Electric Power

Chairman: L. Reiffel, Armour Research Foundation

Co-Chairman: D. C. White, MIT

Nuclear Fuel Cells Research. *R. W. Henderson*, Allison Division of General Motors Corp.

Status of Research in Thermonuclear Power. *Sterling Colgate*, Lawrence Radiation Lab.

Engineering Frontiers of Thermonuclear Power. *C. W. Little, Jr.*, C-Stellerator Associates

Wednesday, March 22

9:00 a.m. Central Stations II, Commercial Operation of the Breed Plant

The Dual Basic Concepts Behind the Breed Plant

As a generating station in the western-most part of the American Electric Power System.

As a new technological frontier in the field of economical mass generation of steam-electric energy.

Chairman: Philip Sporn, president, American Electric Power Service Corp. (AEPSC)

Co-Chairman: E. H. Snyder, Public Service Electric & Gas Co.

The Project. *Philip Sporn*, AEPSC

The Plant. *T. T. Frankenberg*, AEPSC

Steam Generation. *G. W. Bice*, AEPSC

Turbine. *C. P. Lugrin*, AEPSC

Chemistry. *E. B. Morris*, AEPSC

Generator and Electrical Features. *C. P. Zimmerman*, AEPSC

9:00 a.m. Automation and Control

Chairman: J. H. Kinghorn, technical vice-president, Power Division, AIEE, and American Elec. Power Service Corp.

Co-Chairman: M. Riaz, professor of electrical engineering, Univ. of Minnesota

Automation of System Operation. *L. K. Kirchmayer, H. J. Fiedler*, General Elec. Co.

Automatic Power Plants-Application of Control Computers. *B. L. Lloyd, R. B. Squires*, Westinghouse Elec. Corp.

The Installation of Automatic Controls in an Existing Power Plant for Minimum Down Time. *T. H. Bloodworth*, Allis-Chalmers Manufacturing Co.; *J. A. Reich*, Gulf States Utilities Co.; *L. M. Wilson*, Consolidated Systems Corp.

Monitoring, Logging, and Computing Performance for an Existing Coal and Oil Fired Station. *M. J. Feldmann, J. W. Purssell, Jr.*, Boston Edison Co.

9:00 a.m. Fuels

Sponsored by Fuels Division of ASME

Chairman: J. R. Jones, Peabody Coal Co.

Co-Chairman: Julian Meserve, Dow Chemical Co.

Coal Properties as Related to the Corrosion of High-Temperature Boiler Surfaces. *J. T. Reese, James Jonakin*, Combustion Engineering, Inc.; *J. G. Koopman*, Electric Energy, Inc.

Liberation of Pyrite from Steam Coals. *R. A. Glenn, R. D. Harris*, Bituminous Coal Research, Inc.

Effect of Pulverizer Design on Furnace Performance. *H. M. Rayner*, Western Elec. Co.; *P. F. Seibold*, Riley Stoker Corp.

9:00 a.m. Symposium on Peaking I—Hydroelectric

Chairman: A. J. Ackermann, consulting engineer, Madison, Wis.

Co-Chairman: J. R. Villemonte, professor of civil engineering, University of Wisconsin

Session will be devoted to peaking problems which are found on power systems with a substantial amount of hydroelectric generating capacity, resulting in redesign of hydroelectric stations, or in the building of new stations with extremely low capacity factors and high installed capacity to permit carrying short term peaks. One of the papers will discuss the generation of peaking energy from a pumped storage plant specifically constructed for that purpose. Since no two systems are alike, discussions will be welcomed at the session to record briefly various current experiences in meeting exceptional peaks.

9:00 a.m. Water Technology II—Industrial III

Chairman: J. F. Wilkes, director of research and development, Dearborn Chemical Co.

Co-Chairman: A. B. Alter, professor of mechanical engineering, Agricultural & Mechanical College of Texas

Some Practical Solutions to Industrial Water Treatment Problems. *R. S. Walters*, supervisor, U. S. Steel Corp.

Boiler Scale Prevention by Use of Chelating Agents. *J. C. Edwards, E. A. Rozas*, Dow Chemical Co.

Effective Temperature Measurement of Boiler Wall Tubes to Provide Safe Operating Control. *J. W. Strub*, E. I. DuPont de Nemours & Co.

Prevention of Corrosion in Steam Systems under Changing Load Conditions. *Marcel Stein*, Illinois Institute of Technology

12:15 p.m. APC-AIEE Luncheon

Sponsored by AIEE

Chairman: C. H. Linder, president, AIEE

Co-Chairman: W. T. Larner, chairman, Chicago Section AIEE, Illinois Bell Telephone Co.

Speaker: G. E. Drach, Illinois State Senator

Subject: Federal vs. State Regulation in the Development of Atomic Power

2:00 p.m. Nuclear Power Plants

Chairman. R. M. Casper, general manager, Nuclear Power Division, Allis-Chalmers Mfg. Co.

Co-Chairman: C. W. Terrell, supervisor, Reactor Physics Section, Physics Research Division, Armour Research Foundation

The Technical and Economic Status of Central Station Gas Cooled Reactors. *T. G. LeClair*, General Atomic

The Technical and Economic Status of Central Station Boiling Water Reactors. *R. B. Richards*, General Elec. Co.

The Technical and Economic Status of Central Station Pressurized Water Reactors. *J. W. Simpson*, Atomic Power Dept.

2:00 p.m. Symposium on Peaking—Thermal

Chairman: R. H. Bradford, regional manager, Central Region, Ebasco Services, Inc.

Co-Chairman: R. C. Porter, professor of electrical engineering, Univ. of Michigan

Some Fundamental Factors Affecting Peaking. *J. H. Fuston*, Business Research Corp.; *W. A. Lewis*, Illinois Institute of Technology

Electromotive Power for Peaking Area Backup and Reserve. *B. B. Brownell*, General Motors Corp.

Gas Turbines for Peaking. *W. D. Marsh*, General Elec. Co.

2:00 p.m. System Planning and Operation

Sponsored by the Power Division of AIEE

Chairman: E. R. Moore, manager of engineering, Detroit Edison Co.

Co-Chairman: J. J. Carey, professor of electrical engineering, Univ. of Michigan.

Automation of System Planning. *F. J. Maginniss, C. D. Galloway, A. J. Wood*, General Elec. Co.

Results of a Year of Long Range Planning by Simulation. *C. J. Baldwin*, Westinghouse Electric Corp.; *J. A. Casazza*, Public Service Electric & Gas Co.

Co-ordinated Use of Hydro and Steam Generation in a Large Interconnected System. *R. N. Brudenell, J. H. Gilbreath*, TVA

Daily Forecasting of Electric System Loads. *S. S. Claire, W. S. Einwechter*, Phila. Elec. Co.

2:00 p.m. Industrial IV—Central Station III—Steam Generators

Chairman: C. R. Earle, Special Projects editor, *Power Engineering*

Co-Chairman: D. J. Renwick, associate professor of mechanical engineering, Michigan State Univ.

Preventing Furnace Explosions—The Application of Flame Detectors and their Function in a Complete Furnace Protecting System. *W. L. Livingston, P. Gray, Jr.*, Combustion Engineering, Inc.

Flue Gas Sampling and Analysis for O_2 in Cyclone Furnace Fired Boilers. *F. C. Luxl*, Leeds and Northrup Co.; *J. J. Osochowsky*, United Illum. Co.

2:00 p.m. Water Technology III—Condensate Polishing

Chairman: L. F. Wirth, Jr., manager, Ion Exchange Division, Nalco Chemical Co.

Co-Chairman: T. J. Hodan, sales manager, Water Conditioning Section, Allis-Chalmers Mfg. Co.

Plant Experience, High Flow Rate, Externally Regenerated Condensate Polishing Demineralizers, Dresden Nuclear Generating Station. *A. B. Sisson*, Commonwealth Edison Co.; *R. C. Reed*, General Elec. Co.; *H. W. Frazer*, Infilco, Inc.

Condensate Scavenging—Operating Results in Three Central Station Plants. *V. J. Calise, J. A. Levendusky*, Graver Water Conditioning Co.

6:30 p.m. All Engineers Dinner

Presiding: C. J. Forsberg, president, Wisconsin Power and Light Co.

Entertainment: Spartan Bell Ringers of Michigan State University.

Speaker: To be announced.

Thursday, March 23

9:00 a.m. Central Stations IV

Sponsored by the Power Division of ASCE

Chairman: M. P. Aillery, chairman, Power Division, Executive Committee, ASCE, and chief structural engineer, J. C. White Engineering Co.

Co-Chairman: R. N. Bergstrom, associate, Sargent & Lundy

TVA's Paradise Steam Plant with 650,000-kw Units. *R. A. Elliott, W. F. Emmons, H. T. Lofft*, TVA

Application of a Governor Test Facility to Analysis and Design of Steam Turbine Generator Control Systems. *J. K. Dixon*, Allis-Chalmers Mfg. Co.

Comparison of Contractual Arrangements for Utility and Industrial Projects. *W. E. Hopkins*, Stone and Webster Engineering Corp.

Cooling Pond or Cooling Tower—An Over-all Appraisal. *W. R. Steur*, Sargent & Lundy

9:00 a.m. Power Plant Auxiliaries

Sponsored by the Power Division of ASME

Chairman: C. D. Birget, Commonwealth Associates, Inc.

Co-Chairman: K. G. Picha, associate director, School of Mechanical Engineering, Georgia Institute of Technology

Philadelphia Electric Company Multi-Stage Flash Evaporator. *C. Capara, W. B. Willsey*, Phila. Elec. Co.; *D. Crane, E. F. Stalcup*, Westinghouse Steam Division

Corrosion and Vibration in Small Steam Turbines. *Stanford Neal, W. J. Caruso*, General Elec. Co.

Second Progress Report on High Speed Boiler Feed Pumps. *I. J. Karassik, E. F. Wright*, Worthington Corp.

Development and Operation of Fluid Drives for Turbine-Generator Driven Boiler Feed Pumps. *R. D. O'Neil*, American Standard Co.

9:00 a.m. Industrial V—Training of Plant Personnel

Sponsored by NAPE

Chairman: Floyd Cooper, president, NAPE

Co-Chairman: P. M. Anderson, department of mechanical engineering, Iowa State Univ.

On the Job Training for Power Plant Personnel by the Minnesota State Department of Education. *F. W. Randell*, Minnesota State Department of Education

An Adult Education Program for Power Plant Personnel. *H. R. Blount, W. W. Cartwright*, NAPE

The Neglected Area, Training the Handicapped for Service in Industrial Plants. *P. Choncholos, William Kir-Stimon*, Rehabilitation Institute of Chicago

Our Experiences in Instrument Maintenance Training Programs. *R. C. Crambau*, Dow Chemical Co.

9:00 a.m. Electrical Distribution

Chairman: C. L. Welch, Midwestern Region engineering manager, Westinghouse Elec. Corp.

Co-Chairman: R. E. Armington, professor of electrical engineering, Pennsylvania State Univ.

New Developments in Residential Underground Distribution. *R. F. Lawrence, R. B. Pherson*, Westinghouse Elec. Corp.

Overhead Electric Distribution Line Construction Equipment and Practices. *K. S. Field*, Ebasco Services, Inc.

The Self-Regulating Transformer and Its Impact upon Future Distribution Planning. *D. A. Manning*, Line Material Industries and McGraw-Edison Division

Planning for Transition from 4-Kv to 13.2-Kv Distribution. *Raymond Duer*, Cincinnati Gas and Elec. Co.

9:00 a.m. Water Technology IV—Ion Exchange—Operations

Chairman: S. F. Whirl, chemical operating engineer, Duquesne Light Co.

Co-Chairman: W. R. Homan, chief chemist, Commonwealth Edison Co.

Mixed Bed Demineralizers in Series for Optimum Operating Control. *Eugene Schmidt*, L-A Water Conditioning, Inc.; *N. W. Sager*, City of Burbank, Calif.

Four Years Operating Experience with a 3,200 GPM Demineralizer. *R. I. Smith, H. D. Rettin*, Public Service Elec. and Gas Co.

10:30 a.m. Water Technology V—Sea Water Conversion

Chairman: R. A. Lorenzini, vice-chairman, Boiler Feedwater Studies Research Committee, ASME and chief engineer, Foster Wheeler Corp.

Co-Chairman: A. H. Easton, professor of civil and mechanical engineering, Univ. of Wisconsin

Operation of the Sea Water Distillation Plant at Mandalay Station, *R. F. Wistler*, Southern California Edison Co.

The Economics of Sea Water Distillation and Power Generation. *C. F. Sonderman*, Singmaster and Bryer

12:15 p.m. Joint APC-WSE Luncheon

Sponsored by WSE

Chairman: R. D. Maxson, president, WSE

Co-Chairman: J. C. Boyce, vice-president and dean of the Graduate School, Illinois Institute of Technology

Speaker: T. G. LeClair, manager, Nuclear Power Applications, General Atomic

Subject: The Future of Atomic Energy

2:00 p.m. Central Stations V

Chairman: B. G. Elliott, professor emeritus of mechanical engineering, Univ. of Wisconsin

Co-Chairman: R. C. King, associate professor of mechanical engineering, New York Univ.

Improvement in Economics of a 625-Mw Combined Cycle Plant Over a Conventional Steam Cycle Plant. *H. J. Peterson*, United Engineers and Constructors, Inc.; *J. O. Stephens*, Westinghouse Elec. Corp.

Binary Cycle for Power Generation—Steam—Peyton-12 System. *David Aronson*, Worthington Corp.

Automatic Programming for Optimized Power Plant Design. *F. H. Westervelt*, University of Michigan; *C. D. Birget*, Commonwealth Associates, Inc.; *F. C. Fisher*, Consumers Power Co.

2:00 p.m. Electrical Apparatus

Chairman: F. M. Scott, manager, Utility Sales, Allis-Chalmers Mfg. Co.

Co-Chairman: M. S. Helm, professor of electrical engineering, Univ. of Illinois

New Standards for Power Circuit Breakers and their Effect on Design, Test, and Application. *R. C. Van Sickle*, Westinghouse Elec. Corp.

Harmonic Excitation of Synchronous Machines. *F. I. Biggs, P. I. Nippes*, Carrier Corp.

Whys and Hows of Auto-Transformers. *L. R. Reid*, Allis-Chalmers Mfg. Co.

Thermal Upgrading of Power Transformers. *J. H. Carpenter, J. R. Meador*, General Elec. Co.

2:00 p.m. Industrial VI—Economics of Power Plant Operation

Chairman: K. R. Hodges, chief engineer, Sears Roebuck and Co.

Co-Chairman: Roy Sahlstrom, Faville LeVally Corp.

How Small Plants Can Conserve Utilities and Reduce Cost. *G. R. Chadwick*, consulting engineer

Controlling the Cost of Electricity for Industrial Plants. *R. H. Bradford*, Ebasco Services, Inc.

Departmental Allocation of Plant Utility Rates. *M. B. Golber*, Armour & Co.

2:00 p.m. Computers and Network Analyzers

Chairman: E. L. Nicolson, manager, application engineering, General Elec. Co.

Co-Chairman: E. B. Eggers, research engineer, Illinois Institute of Technology

Digital Load Flow Techniques. *J. J. Skiles*, University of Wisconsin and consultant to Allis-Chalmers Mfg. Co.; *J. B. Cage*, mathematician; *H. D. Bickley*, Allis-Chalmers Mfg. Co.

Digital Solution of Power System Transcients. *L. O. Barthold*, General Elec. Co.

Co-ordinated Operation of a Medium Sized Digital Computer and A-C Network Analyzer. *H. D. Hunkins*, Bureau of Reclamation, Department of the Interior

Automatic Writeout Equipment Used with A-C Nework Calculator. *R. E. Gilbreath*, Westinghouse Elec. Corp.

Improvements in Bonneville Network Analyzer. *K. Tuttle*, Bonneville Power Admin.

2:00 p.m. Atmospheric Pollution

Sponsored by the Power Division of ASME

Chairman: R. M. Vanduzer, Detroit Edison Co.

Co-Chairman: G. L. West, Jr., Department of Naval Architecture and Marine Engineering, Univ. of Michigan

Atmospheric Pollution Prediction by Model Studies of Industrial Stacks. *F. K. Boutwell*, Univ. of Michigan

Topographical Influence on the Behavior of Stack Effluents. *F. W. Hewson, E. W. Bierly, G. C. Gill*, Department of Civil Engineering, Univ. of Michigan

Review of Commonwealth Edison Company's Experience with Precipitators. *M. J. Archbold*, Commonwealth Edison Co.

3:30 p.m. Central Stations VI—Optimization and Control

Chairman: E. T. B. Gross, professor of electrical engineering, Illinois Institute of Technology

Co-Chairman: D. H. Madsen, professor of mechanical engineering, State Univ. of Iowa

Automatic Programming for Optimized Power Plant Design. *F. H. Westervelt*, Univ. of Michigan; *C. D. Birget*, Commonwealth Associates, Inc.

An Integrated Turbine-Reactor Control System for the Sodium Reactor Experiment. *R. J. Hall*, Atomics International, Division of North American Aviation, Inc.; *F. C. Six*, Leeds and Northrup Co.

Joint Conferences Planned on Rural Electricity—Appliances

Louisville, Ky., will be the site of the AIEE's Domestic and Commercial Applications Committee's annual Technical Conferences on Rural Electrification and Domestic Appliances. B. F. Parr is national committee chairman while the host Louisville Section is headed by H. N. McGinnis. The meeting will be opened at the Kentucky Hotel, with a joint registration and general meeting. Separate technical sessions on Rural Electrification with H. T. Smith, committee chairman, and Domestic Appliances with W. F. Kindt, committee chairman, will be held.

Appropriate field trips are being arranged. Louisville is noted for its appliance, automobile, chemical processing, distillery, and tobacco industries. It is also the home of Churchill Downs and the Kentucky Derby; horse racing season will be under way during the week of the conference.

Conference Papers Open for Discussion

Conference papers listed below have been accepted by AIEE *Transactions* and are now open for written discussion until March 27. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, AIEE, 33 W. 39th St., New York 18, N. Y., on or before March 27.

60-227	**Switching Characteristics of Silicon Power-Controlled Rectifiers. I. Turn-On Action.** *I. Somos*
60-230	**Ultrahigh-Temperature (500 C) Electronic Transformers. Part II. Design Optimization.** *G. Walters*
60-231	**Ultrahigh-Temperature (500 C) Electronic Transformers. Part I. Design Considerations.** *J. F. Rippin, Jr., H. B. Harms, G. Walters*
60-642	**Automatic Speed Regulation of D-C Motors Using Combined Armature Voltage and Motor Field Control.** *Ansgar Hansen, A. W. Wilkerson*
60-645	**Wide-Range D-C Center Wind Drive.** *Byron Jones, Thomas Pare*
60-649	**A-C Contactors Supplied by Long Control Lines.** *R. P. Alley*
60-844	**Incremental Cost of Water Power.** *S. Stage, Y. Larsson*
60-846	**Methods of Controlling Generation on Interconnected Power Systems.** *Nathan Cohn*
60-851	**Performance of A New Static-Magnetic Exciter and Voltage Regulator for Round-Rotor Marine Steam-Turbine Generators.** *D. F. Talcott, P. M. Tabor, C. Concordia*
60-852	**A New Frequency Converter Excitation "FCE" System for A-C Generators.** *K. M. Sparrow*
60-874	**Initiation of Flux Reversal in Magnetic Amplifier Cores.** *F. J. Friedlaender, I. P. Leliakov*
60-1005	**Rotating Raster Character Recognition System.** *R. W. Weeks*
60-1018	**Stochastic Time Optimal Control Systems.** *Masamao Aoki*
60-1019	**A Digital Time Domain Synthesis Technique for Feedback Control Systems.** *L. E. Weaver, A. P. Sage, R. L. Miller, Jr.*
60-1226	**E-Algebras in Switching Theory.** *Warren Semon*
60-1229	**Logical Design by Regression (Matrix Logic VII).** *E. J. Schubert*
60-1282	**Magnetization and Pull Characteristics of Mating Magnetic Reeds.** *R. L. Peek, Jr.*
60-1400	**Operation of A Hydro-Thermal Electric System — A Multi-Stage Decision Process.** *J. Lindqvist*
60-1407	**Data Gathering and Transmission System for Project EHV.** *P. A. Abetti, D. W. Caverly, D. D. Davis, E. A. Whepley*

Preprints may be purchased at 50¢ each to members, $1.00 to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 W. 39th St., New York 18, N. Y.

RECIPIENT of the 1960 Hoover Medal, President Eisenhower (*right*) accepts the award from W. L. Cisler (*left*), president of the Detroit Edison Company and chairman of the Hoover Medal Board of Award, at a dinner in Washington, D. C., on January 10.

Hoover Medal Is Presented to President Eisenhower for Leadership

FOR the second time, a President of the United States has received the Hoover Medal, sponsored by four of the nation's leading engineering societies. Dwight D. Eisenhower was awarded the medal at a dinner in Washington, D.C., on January 10. Herbert Hoover, after whom the medal is named, was its first recipient in 1930.

W. L. Cisler, president of the Detroit Edison Company, past president of the American Society of Mechanical Engineers, and chairman of the Hoover Medal Board of Award, made the presentation.

Citation Given

President Eisenhower's citation from the engineering group reads: "History records the leadership in world peace which Dwight David Eisenhower has given to all people in preparing and directing undertakings of monumental engineering dimensions in military and civilian operations of great magnitude and far reaching significance. As organizer, leader, and our President, he has throughout his illustrious career given proof of the importance of the individual by the impact of his actions in building a better world for people everywhere."

Sponsors of the Award are AIEE, the American Society of Civil Engineers, the American Institute of Mining, Metallurgical, and Petroleum Engineers, and the American Society of Mechanical Engineers.

Speaker at the dinner was S. L. A. Marshall, Brigadier General, retired, U. S. Army. His topic was: "The Engineering Victory of the European Theater of Operations." General Marshall, who was historian of a number of major military activities of World War II, is now military critic and editorial writer of the *Detroit News*. His military column is nationally syndicated.

Former Recipients Named

Previous recipients of the Award are:

1930—Herbert Hoover
1936—Ambrose Swasey
1938—Gano Dunn
1941—D. R. Yarnall
1942—Gerard Swope
1944—R. E. Flanders
1945—W. H. Harrison
1955—C. F. Kettering
1956—Herbert Hoover, Jr.
1957—Scott Turner
1958—R. A. Wheeler
1959—H. T. Heald

5th Midwest Symposium on Circuit Theory Scheduled

Topology in circuit theory will be studied at the 5th Midwest Symposium on Circuit Theory on May 6, 8, and 9 at the University of Illinois. Sponsors of this meeting are: AIEE Basic Sciences Committee, the Institute of Radio Engineers' Professional Group on Circuit Theory, and the University of Illinois' department of electrical engineering.

The tentative technical program follows:

Saturday, May 6

Workshop in Graph Theory

Lectures by *S. L. Hakimi, W. Mayeda*, Univ. of Illinois; *M. B. Reed*, Michigan State Univ.; *S. Seshu*, Syracuse Univ.; *Louis Weinberg*, Hughes Research Labs.

Monday, May 8

Morning Session

Chairman: R. M. Wainwright, Good-All Elec. Mfg. Co.

Address of Welcome. E. C. Jordan, Univ. of Illinois

Network Applications of Graph Theory. *Sundaram Seshu*, Univ. of Syracuse. Commentator: P. R. Bryant, General Elec. Co.

Linear Graphs: A Few Reflections on Its Future in the Curriculum and in Research. *Louis Weinberg*, Hughes Research Labs. Commentator: H. E. Koenig, Michigan State Univ.

Flowgraphs for Nonlinear Systems. *T. A. Bickart*, Johns Hopkins Univ. Commentator: C. L. Coates, General Elec. Co.

Afternoon Session

Chairman: B. R. Myers, Univ. of Waterloo

The Seg: A New Class of Subgraphs. *M. B. Reed*, Michigan State Univ. Commentator: E. W. Hobbs, McDonnell Aircraft Co.

A Method of Tree Expansion in Network Theory. *Hitoshi Watanabe*, Nippon Elec. Co. Commentator: W. H. Kim, Columbia Univ.

On Realizability of a Set of Trees. *S. L. Hakimi*, Univ. of Illinois. Commentator: K. A. Pullen, Aberdeen Proving Ground

Evening Session

Panel Discussion: The Historical Development of Circuit Theory. *H. W. Bode, Sidney Darlington*, Bell Telephone Labs.; *E. A. Guillemin*, MIT

Tuesday, May 9

Morning Session

Chairman: A. B. Macnee, Univ. of Michigan

On the Synthesis of Resistive N-Port Networks. *G. Biorci, P. P. Civalleri*, Instituto Elettrotecnico Nazional. Commentator: Satio Okada, Stromberg-Carlson

Paramount Matrices and Synthesis of Resistive N-Ports. *I. Cederbaum*, Columbia Univ. Commentator: F. M. Reza, Syracuse Univ.

On the Synthesis of R-Networks. *D. P. Brown, Y. Tokad*, Michigan State Univ. Commentator: H. C. So, Univ. of Rochester

Afternoon Session

Chairman: W. B. Boast, Iowa State Univ.

Analysis and Synthesis Techniques of Oriented Communication Nets. *D. T. Tang, R. T. Chien*, IBM Research Labs. Commentator: S. S. Yau, Univ. of Illinois

Optimal Synthesis of a Communication Net. *Omar Wing*, Columbia Univ.; *R. T. Chien*, IBM Research Labs. Commentator: W. Mayeda, Univ. of Illinois

The Structures of Switching Nets. *Lars Lofgren*, Univ. of Illinois. Commentator: P. M. Lewis, General Elec. Co.

Note 1: Papers presented at the Symposium will be published in the March 1961 issue of the Institute of Radio Engineers (IRE) *Transactions on Circuit Theory.*

Note 2: Information concerning housing at Allerton Park and registration may be obtained by writing to Prof. M. E. Van Valkenburg, Department of Electrical Engineering, Univ. of Illinois, Urbana, Ill.

Stanley Seligson

ACCEPTING the gavel from A. B. Kinzel (*left*), EJC president for 1960, is J. N. Landis (*right*), vice-president of the Bechtel Corporation, who will head EJC as its president for 1961. Mr. Landis received the gavel at the EJC annual meeting on January 19.

EJC Begins New Year with Annual Meeting in New York

THE annual meeting of the Engineers Joint Council (EJC) was held Thursday, January 19, at the Biltmore Hotel, New York, N. Y.

An open meeting for the transaction of regular business was held during the morning, with EJC President A. B. Kinzel presiding. Following a formal recognition of outgoing members of the Board of Directors and approval of the minutes, the report of the Finance Committee was presented by W. E. Lobo, chairman.

As the result of a change in the Constitution, reported E. J. Kates, chairman of the Constitution and Bylaws Committee, dues for affiliate members are now $100 per year minimum.

Vice-Chairman H. G. Dixon of the Engineering Manpower Commission Committee stated that work is nearly completed on a survey of engineering salaries, and that a report will be released within the next few months.

Appreciation Certificate Presented

A certificate of appreciation was awarded to Gen. S. E. Reimel for his many years of invaluable service by the International Relations Committee.

F. D. Kay, chairman of the Membership Committee, reported that the Chinese Institute of Engineers and the American Society of Testing Materials have been admitted to EJC as affiliates, and the American Society of Agricultural Engineers has been transferred from affiliate to constituent grade.

W. E. Lobo reported briefly on the EJC mission to the Soviet Union, which took place during June and July 1960. A team of six engineers from the United States visited various higher educational establishments, industrial plants, and institutions that train technicians. A full report of their findings and observations will be forthcoming shortly.

EJC's Newspaper Described

Carleton Pearl, editor of *Engineer*, EJC's new newspaper, described its progress. The first issue came out in the Fall of 1960 and was mailed to members of the constituent societies. It is anticipated that in the future the newspaper will carry some advertising. Present plans call for four issues during 1961, the first to appear this Spring.

The last item on the agenda was the introduction of the 1961 president, J. N. Landis, vice-president of the Bechtel Corporation, who received the gavel from President Kinzel.

At the luncheon session, Col. D. D. Omer, deputy director of the Selective Service System, discussed some of the problems involved in determining policies for the best utilization—military or civilian—of young engineers, scientists, and other technically trained personnel.

During the afternoon, seven members of a panel covered various areas of interest of EJC. President Landis opened the session with a brief resume of EJC's role in society and in the profession.

George Browne covered some of the international opportunities and obligations of engineers. He stressed the increase in opportunities abroad, particularly in underdeveloped countries. He also pointed out the necessity for supplementing our engineering techniques with knowledge of other cultures. The EJC Committee on International Relations has acted as spokesman of the engineering societies throughout the world in such areas as government and international organizations, engineering societies in other countries, and in UPADI, the Pan-American Federation of Engineering Societies. Five of the projects in which the Committee has been particularly active during the last year have been participation in the congress on engineering education held in Buenos Aires, Argentina, and in a program for the exchange of engineers with other nations.

Need for Co-operation Stressed

G. E. Holbrook pointed out the compelling need for more co-operation and communication among societies and members of societies. He stated that the autonomy of societies, while important, should not transcend the needs of the profession. AIEE President Linder commented on the need for exchange of technical information between groups and cautioned against unnecessary and duplicate meetings. He cited the success of technical conferences on specific subjects which have been sponsored jointly by AIEE and other groups. The text of his comments appear on pp. 204-05 of this issue.

T. O. Paine of the Engineering Research Committee discussed some of the questions being explored by the Committee, including relative priorities of the technical needs throughout the world, future transportation needs of the United States, relations between national resources and sources of energy, interaction between medical and engineering technology, and the role of professional societies.

Other reports were made by R. K. Honaman on problems and needs in the area of information flow, by S. B. Ingram on the various aspects of engineering manpower and the continuing shortage of engineers, and by M. D. Hooven on the needs for a thorough evaluation of the engineering profession.

At the annual dinner, Dr. Detlev Bronk, president of the National Academy of Sciences, spoke on the challenging future of engineering. He stated that the engineer is a scientist who is more than a scientist; it is his concern to extend the powers of the normal human body.

He cited some of the things that have been accomplished in the fields of communication, transportation, and the exploration of space in less than 15 years. However, he also pointed out that millions in the world do not have even the barest rudiments of comfort, and thus cannot enjoy the spiritual evolution science can give to man. "Perhaps," he said, "the men whose business it is to apply knowledge should direct its application."

In closing, Dr. Bronk said that since science has increased the years between birth and death, we should now ask science to make fuller the lives that are lived.

Rothschild

AIEE'S HISTORY and its future were discussed at the January meeting of the Los Angeles Section. Prominent among those who attended were: *(left to right)* Robert Milmoe, Section chairman; C. H. Linder, AIEE president and guest speaker at the Section meeting, and Dr. R. A. Sorenson, past president of AIEE and honorary president of the Royal A. Sorenson Fellows of the Los Angeles Section.

Los Angeles Section Is Addressed on AIEE's History and Its Responsibilities

AIEE and its potential responsibility in the years ahead was the subject of a talk by C. H. Linder, AIEE president, at the January 17 dinner meeting of the Los Angeles Section.

This responsibility includes not only a recognition of organizational and operational problems within AIEE and other technical and professional societies, Mr. Linder explained, but also a realization of our obligation, through technological development, to society as a whole.

As a group of professional people, the AIEE must be sensitive to and deeply concerned with some of the national and international problems about us. Since ours is a dynamic society, we must be alert to recognize environmental changes and meet them with understanding.

Nation's Status Viewed

Mr. Linder touched briefly on our status as a nation, identifying such problems as the fantastic rate of growth of our fund of technical knowledge and the increasing difficulty of "getting at it," the population explosion and its national effect, our national economic position on the world market, and how the United States has changed from a "have got" nation to a "need" nation. Today, 45% of the free world raw materials are used by the United States, and Mr. Linder called upon the engineering profession to meet foreign economic pressures through the use of "imaginative engineering in the choice of future designs." He emphasized that the engineering society is in a position to make a significant contribution to the management of our technology.

The internal problems of technical societies were explored in some detail by Mr. Linder. He reviewed the problem of unity among such societies and the lack of progress during the 25 to 30 years of consideration. Mr. Linder stressed the need of directing every effort toward uniting and providing platforms for new needs of common interest within current structures to avoid a constant increase in technical societies. Technical meetings taking place at the same time on the same subject were considered as "wasting time, energy, and the members' money."

In the matter of unity, Mr. Linder pointed out that the high officers of each society could not solve all the problems involved. We as technical society members must determine, at a grass-roots level, what technical information is desired and then move in the direction of more common meetings. The primary objective of the technical society is the dissemination of technical information, and this can best be accomplished by being responsive to the changing technological needs of our environment.

Color Slides Illustrate Presentation

Mr. Linder concluded his presentation with a series of color slides which graphically traced the history of AIEE and other technical societies, relating such items as membership growth, number of committees, operating expenses, number of societies, and allied statistics.

An added event at this meeting was the presentation of the AIEE Los Angeles Section's first Electrical Engineering Scholarship Award. This award is to be made on an annual basis as determined by the head of the electrical engineering department of the school selected to receive the award.

Because the California State Polytechnic College has the most active student branch of the five within the Los Angeles Section, the first award was made to this institution. F. W. Bowden, head of the electrical engineering department at California State Polytechnic, selected D. W. Allen to receive the award. Mr. Linder made the scholarship presentation to Mr. Allen during the dinner meeting.

Electric Welding Conference Set for April 18-19 in New York

The AIEE Electric Welding Conference will be held jointly with the American Welding Society (AWS) during the AWS annual meeting which is scheduled for the week of April 17-21 at the Hotel Commodore in New York City. The AIEE sessions will be held April 18-19.

Aside from the technical sessions, there will be a session during the morning of the opening day which will cover introductions, opening remarks, and special awards. A reception, followed by an annual dinner, will be held on that evening.

A tentative program of the technical sessions which the AIEE will conduct at the conference follows:

Tuesday, April 18

9:30 a.m. Session IV—Resistance Welding

*Standards for Resistance Welding Control. *R. C. Mierendorf*, Square D Co.

Applying Static Control to Resistance Welding. *C. F. Meyer, W. J. Brown*, Square D Co.

Instrumentation in Automotive Resistance Welding. *E. J. Zulinski*, Ford Motor Co.

Load Control for Resistance Welding. *R. E. Rogers*, Instrument Control Co.

2:00 a.m. Session VII—Arc Welding

Electrical and Metallurgical Factors Influencing Welding Arc Stability. *J. E. Ginn*, Boeing Airplane Co.

Wave Shape Effect on Alloying and Arc Stability of Alternating Current Tungsten Inert Arc Welding. *T. B. Correy*, General Elec. Co.

Some New Concepts in Power Supplies and Arc Initiation Applied to TIG Spot Welding. *Marcel Sommeria*, Sciaky Bros., Inc.

Wednesday, April 19

9:30 a.m. Session II—Arc Welding

A Double Taper Tungsten Arc Welding Control. *Austin Dixon*, Westinghouse Elec. Corp.

New Developments in Electron Beam Welding Machines. *J. L. Solomon*, Sciaky Bros., Inc.

Development of a Power Supply for Stored Energy Arc Welding. *C. C. Stone, R. A. Noland*, Argonne National Lab.

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*Paper based on a tentative Standard prepared by the National Electrical Manufacturers Association and the Resistance Welder Manufacturers Association.

DISCUSSING final plans for the 1961 Western Joint Computer Conference are: (*left to right, standing*) John Whitlock, exhibits management; Santo Lanzarotta, public relations; Smil Ruhman, associate program chairman; L. C. Hobbs, printing; Marvin Howard, registration; William Speer, finance; and (*seated*) J. D. Madden, associate program chairman; R. H. Hill, exhibits; Dr. R. W. Rector, conference administrator; Dr. W. F. Bauer, general chairman of the 1961 meeting; Keith Uncapher, conference vice-chairman; and R. D. Aeder, publications.

Computer Conference Is Scheduled for May 9-11

Arrangements Committee chairmen for the Western Joint Computer Conference recently discussed final plans for the May 9-11 meeting to be held at the Ambassador Hotel in Los Angeles, Calif. More than 2,000 registrants are expected to attend the 9th annual conference and view more than 90 industry exhibits.

Committee chairmen include the following: John Whitlock, exhibits management; Santo Lanzarotta, public relations chairman, *Datamation* magazine; Smil Ruhman, associate program chairman, Packard Bell Computer Division; L. C. Hobbs, printing chairman, Aeronutronic Division of Ford Motor Company; Marvin Howard, registration chairman, Thompson Ramo Wooldridge, Inc.; William Speer, finance chairman, Norden Division of United Aircraft Corporation; J. D. Madden, associate program chairman, System Development Corporation; R. H. Hill, exhibits chairman, Thompson Ramo Wooldridge, Inc.; Dr. R. W. Rector, conference administrator, Space Technology Laboratories; Dr. W. F. Bauer, general chairman of the 1961 meeting, Thompson Ramo Wooldridge, Inc.; Keith Uncapher, conference vice-chairman, Rand Corporation, and R. D. Aeder, publications chairman, IBM Corporation; William Dobrusky, hotel arrangements, Systems Development Corporation; Dr. C. T. Leondes, program chairman, University of California at Los Angeles; Paul Armer, associate program chairman, Rand Corporation; Mrs. Phyllis Huggins, women's activities, Bendix Corporation; and Joel Herbst, trips, Telemeter Magnetics, Inc.

Denver Engineers Conduct Panel Meeting on Achieving Unity

Four prominent Denver, Colo., engineers recently participated in a panel discussion on "Organizing the Engineering Societies for Unity" at a joint meeting in Denver of the local chapters of AIEE, the American Society of Mechanical Engineers, and the American Institute of Chemical Engineers.

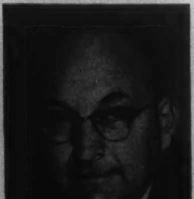
A. E. Paige, head of the electrical engineering department at the University of Denver, was moderator of the panel. At the opening of the discussion, he stated:

"Existing technical societies are highly successful organizations and serve their members well in the technical field. The need for greater unity in the engineering profession arises chiefly from the increasing number of legal, political, ethical, educational, and economic problems with which engineers are confronted, and many hope and believe there is a way for engineers to be more effective in their relations with each other and with the public they serve. As a result, there have been several proposals for organizing the profession to achieve unity."

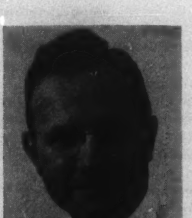
M. H. Kight of the U. S. Bureau of Reclamation presented the Functional Plan proposed by AIEE, and W. H. Parks, head of the mechanical engineering department at the University of Denver, described the Amalgamated Plan proposed by the Engineers Joint Council. L. M. Robertson, manager of engineering for the Public Service Company of Colorado, gave a summation of the Unity problem.

These four men have been active in promoting unification of the engineering profession.

M. H. Kight



A. E. Paige



Boeing Airplane Co.

W. H. Parks

Public Service Co. of Colorado

L. M. Robertson

Packaging Subcommittee To Meet Industry-Wide Problem

Generally chaotic conditions in the requirements for and use of electric equipment in connection with packaging machinery have led to the formation of a special industry-wide group to meet the problem. Formed late in 1959, it is the AIEE Packaging Industry Subcommittee of the General Industry Applications Committee (GIAC).

The greater use of semi-automatic and fully automatic packaging machinery has helped to bring to a head the growing problem of specification and maintenance of the electric equipments used in connection with it.

The rapid growth of automation in the packaging line has proved troublesome not only to the packagers but to the suppliers of packaging machinery and the manufacturers of electric equipment. Training of packaging line operators and of packagers' purchasing agents is required to meet the situation as well. Additionally, greater understanding of packaging machinery demands on electric wiring and equipment seems requisite on the part of the electrical manufacturing and maintenance industry. Standardization of electric equipment is also a major factor for consideration. This would simplify the problems of the packaging machines operator and maintenance man, the packaging equipment supplier (purchaser of electric equipment), and the electrical manufacturer.

Purpose of the Packaging Subcommittee, as stated by G. W. Knapp of General Electric Company, GIAC chairman, is to concentrate on application problems, look on the over-all problem in terms of results, sponsor forums for idea exchange, and formulate standards by which the entire industry will benefit financially.

Study of the electric equipment situation as related to packaging disclosed a lack of complete understanding of the problems of both the packaging and the electrical industries, with resulting unsuitable electrical performance.

The new AIEE subcommittee received immediate support from packaging organizations, including the Packaging Machinery Manufacturers Institute and the Packaging Institute. Membership in the packaging subcommittee is confined to qualified electrical personnel and to those having direct electrical responsibility and understanding of the many aspects and problems relating to the packaging industry.

After a year of intense organizational work and preliminary discussions, the AIEE subcommittee is now ready to report to and receive reports from both the electrical and packaging industries. The First Technical Conference of the Packaging Industry Subcommittee has been scheduled for May 1961. Enthusiastic response from packaging and electrical people presages success for the conference.

The chairman of the subcommittee is J. D. Ramsey, manager of electrical engineering, Campbell Soup Company. The vice-chairman is F. R. Cinco, chief electrical engineer, Package Machinery Company. I. E. Eliasson, manager of New York sales, Machinery Electrification, Inc., is secretary.

IAEA Offers Scientists Training and Exchange Programs

One of the major areas of assistance to the 73 member states by the International Atomic Energy Agency (IAEA) lies in the training and exchange of scientists and experts.

Since the inception of the fellowship and training activities of IAEA in 1958, the Agency's objectives are being directed towards a fellowship program and an exchange program. The entire activity is closely integrated to provide a variety of training opportunities relating to the peaceful uses and applications of nuclear energy and its technology.

The IAEA fellowship program provides three broad types of training:

1. General techniques training to develop skill in the use of some fundamental techniques in the domain of atomic energy.

2. Specialist training to prepare specialists in the theoretical and experimental aspects of the science and technology of nuclear energy.

3. Research training to provide advanced training, including active participation in research work, for persons potentially qualified to develop and carry out research programs in the basic sciences and engineering.

While the fellowship program is concerned with training the individual student, the exchange program aims at improving teaching and research facilities in general, and offers a wide variety of methods of achieving this objective, which includes in particular:

1. Visiting professors or scientists.

2. Organization of training courses, refresher courses, and educational seminars.

3. Regional training centers.

4. Research and special grants.

5. Visits by scientists to foreign centers.

The individuals who are sent abroad or to whom grants are made are not students in the usual sense, but qualified scientists or teachers who, through such visits or grants, can contribute more effectively to scientific progress upon return to their own countries.

The permanent seat of the Agency is in Vienna, Austria, where the first session of the General Conference was held in October 1957. The Agency's Statute was approved the previous year at an international conference held in New York at United Nations headquarters.

Expert Discusses Approach to Standardization of Instruments

"A New Approach to Electrical Instrument Calibration" was discussed at a meeting of the AIEE Detroit Section on January 24 at the Detroit Institute of Technology by K. J. Koep, senior engineer, Test Equipment, of Daystrom, Inc., Weston Instruments Division.

"Keeping pace with the expanding needs of modern technology requires that industry maintain the highest standards for its basic instruments," emphasized Mr. Koep. As a solution to the usual need for highly trained technicians and time-consuming standardization procedures, he suggested the speed and accuracy of new available calibration consoles which permit even an unskilled operator to calibrate instruments to an accuracy of 0.05% of indicated value.

"Circuit techniques enable a wide variety of output magnitudes to be obtained from one console," he said, "thereby eliminating the necessity for having the large number of standards normally required."

AIEE PERSONALITIES

Named Fellows of the Institute of Radio Engineers as of January 1, 1961, are the following: **Paul Adorian** (M '41), managing editor, Associated-Rediffusion, Ltd., London, England; **S. S. Attwood** (AM '21, F '43, Member for Life), professor, dean of engineering, University of Michigan, Ann Arbor, Mich.; **G. S. Axelby** (AM '51, M '57), Westinghouse Electric Corporation, Baltimore, Md.; **S. H. Dike** (AM '42, M '51), president, Dikewood Corporation, Albuquerque, N. Mex.; **W. C. Dunlap, Jr.** (M '51), director, semiconductor research, Raytheon Company, Waltham, Mass.; **H. L. Flowers** (AM '39, M '47), director, weapon systems, Goodyear Aircraft Corporation, Akron, Ohio; **E. H. Greibach** (M '43), president, Greibach Instruments Corporation, New Rochelle, N. Y.; **D. D. Grieg** (AM '39), president, Electronic Research Associates, Cedar Grove, N. J.; **C. E. Hastings** (AM '36, M '43), president, Hastings-Raydist, Inc., Hampton, Va.; **Y. H. Ku** (F '45), Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa.; **H. A. Leedy** (M '46), vice-president, Armour Research Foundation, Chicago, Ill.; **G. D. McCann, Jr.** (AM '38, F '50), professor, California Institute of Technology, Pasadena, Calif.; **M. E. Mohr** (AM '39, M '53), vice-president, Operations, Thompson Ramo Wooldridge, Inc., Los Angeles, Calif.; **D. C. Ports** (AM '38, M '47), vice-president, Jansky & Bailey, Inc., Washington, D. C.; **H. I. Romnes** (AM '41, F '57), president, Western Electric Company, New York, N. Y.; **L. S. Schwartz** (AM '45, M '48), professor, College of Engineering, New York University, New York, N. Y.; **R. M. Somers** (AM '29, M '42), director of engineering, Bendix Aviation Corporation, Kansas City, Mo.; **E. K. Stodola** (AM '37, M '47), Reeves Instrument Corporation, Garden City, N. Y.; **C. R. Wischmeyer** (AM '40, F '51), master of Baker College, Rice Institute, Houston, Texas; and **A. M. Zarem** (AM '43, M '50), president, Electro-Optical Systems, Inc., Pasadena, Calif. Mr. Dunlap has served on the following AIEE Committees: Basic Sciences (1951-61, chairman 1957-59); Science and Electronics Division (1957-60), and Solid-State Devices (1960-61). Mr. Flowers is a member of the AIEE Electronics Committee (1949-61, chairman 1959-61) and Science and Electronics Division Committee (1959-61). Mr. Hastings has served on the AIEE Recording and Controlling Instrumentation Committee (1959-60). Mr. Ports is a member of the following AIEE Committees: Electronic and High Frequency Instruments (1956-61, chairman 1958-60), Instrumentation Division (1958-60), and Automation and Data Processing (1958-60). Mr. Romnes served on the Communication Division Committee (1949-56, chairman 1949-51). Mr. Schwartz is a member of the AIEE Communication Theory Committee (1957-61, chairman 1959-61) and Communication Division Committee (1959-61). Mr. Zarem serves on the AIEE Electronics Committee (1948-61, chairman 1955-57).

H. C. Anderson, Jr. (AM '49) and **J. M. Tomme** (AM '54) have recently been promoted by Southern States Equipment Corportation of Hampton, Ga. Mr. Anderson, who has been with Southern States since 1946, has been named sales manager—protective equipment. Mr. Tomme has been associated with the corporation since 1953 and is now sales manager—power switching equipment.

L. V. Berkner (AM '29, F '47), president of Associated Universities, Inc., has been elected president for 1961 of the Institute of Radio Engineers (IRE). The IRE vice-president representing overseas countries for 1961 will be **Franz Ollendorff** (M '54), research professor at the Technion-Israel Institute of Technology, Haifa, Israel. The IRE vice-president representing North America will be **J. F. Byrne** (AM '41), manager of the Riverside Research Laboratory, Motorola, Inc., Riverside, Calif. Elected as directors for the 1961-63 term are **E. F. Carter** (AM '24, M '47), director and member of the Board of Directors, Stanford Research Institute, Menlo, Park, Calif. Regional directors of IRE elected for 1961-62 are as follows: Region 2—**A. B. Giordano** (AM '40, M '57), associate dean in charge of the Graduate School and professor of electrical engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.; Region 4—**A. B. Bereskin** (AM '42, M '47), professor of electrical engineering, University of Cincinnati, Cincinnati, Ohio; Region 6—**M. W. Bullock** (M '57), engineering manager, Continental Electronics Manufacturing Company, Dallas, Texas. Mr. Giordano has served on the AIEE Electronic and High Frequency Instruments Committee (1957-60).

L. V. Berkner (AM '29, F '47) has been elected president of the Graduate Research Center, Dallas, Texas. Dr. Berkner will join the Center from Associated Universities, Inc., New York, where he has been president for 10 years.

Ralph Bown (M '30, F '41), renowned former Bell Telephone Laboratories scientist, **E. A. Guillemin** (AM '24, F '51), Webster professor of electrical engineering at the Massachusetts Institute of Technology, and **P. C. Goldmark** (M '45, F '54), Columbia Broadcasting System Laboratories, Stamford, Conn., were among those named by the Institute of Radio Engineers (IRE) to receive awards in 1961. Dr. Bown was named to receive the Founders Award, 1961, "for outstanding service to the IRE and for outstanding contributions to the radio engineering profession through wise and courageous leadership in the planning and administration of technical developments which have greatly increased the impact of electronics on the public welfare." Dr. Guillemin will receive the Medal of Honor, 1961, the highest annual technical award in the field of electronics. Dr. Guillemin will be given the award "for outstanding scientific and engineering achievements." The Prize Award by Vladimir K. Zworykin, 1961, awarded to a member of the IRE for important technical contributions to electronic television, will be given to Dr. Goldmark "for important contributions to the development and utilization of electronic television in military reconnaissance and in medical education." Mr. Goldmark serves on the AIEE Television and Aural Broadcasting Systems Committee (1949-61).

G. R. Bright (AM '55), formerly with the Aluminum Company of America, Massena, N. Y., has recently been appointed to the staff of our Y-12 Plant, Oak Ridge, Tenn. This is an Atomic Energy Installation operated by Union Carbide Nuclear Company, a division of Union Carbide Corporation.

A. J. Buchtenkirch (AM '43) has been appointed manager of instrument sales for Kollsman Instrument Corporation. Prior to his present appointment, Mr. Buchtenkirch was eastern regional sales manager for Giannini Controls Corporation.

Milton Castro (AM '57) has been appointed associate in charge of electrical engineering of Victor M. Garcia Associates, consulting engineers, Santurca, P. R.

Donald Christiansen (AM '51) has been named to the new post of manager of publications for the CBS Electronics division of Columbia Broadcasting System, Inc. Mr. Christiansen was previously manager of information services.

E. A. Clarke, Jr. (AM '53) has been promoted to staff engineer in the applied mathematics and computing section of the Technical Division at the Baytown, Texas, refinery of Humble Oil & Refining Company's Humble Division.

R. R. Cope (AM '46) has been appointed general sales manager of Rea Magnet Wire Company, Inc., a division of Aluminum Company of America. Mr. Cope will direct the sale of aluminum magnet wire and aluminum foil and sheet strip conductors.

J. B. Cottell (AM '49, M '57), former president of Continental Electric Equipment Company, Cincinnati, Ohio, has been elected chairman of the board.

M. W. Cresap (Affil '59), president, Westinghouse Electric Corporation, Pittsburgh, Pa., has been elected a trustee of the Carnegie Institute of Technology.

H. F. Dart (AM '20, F '58), patent engineer of the Westinghouse Electronic Tube Division at Elmira, N. Y., retired October 31 after a 43-year career in the electrical industry. A veteran of the early development of radio, Mr. Dart was instrumental in the evolvement of many advances in electronic tubes, including oxide coated cathodes and a-c heater receiving tubes, both of which are in use today. He worked on basic designs for such early radio tubes and devised improved methods for testing tubes. As a Signal Corps officer in World War I, Mr. Dart installed some of the first radios on aircraft and trained 300 radio electricians for the Army at Indiana University. Following the war, he prepared the first radio engineering course offered by the International Correspondence Schools and taught electrical courses at Rice Institute and Harvard Engineering School. When Mr. Dart joined Westinghouse at Bloomfield, N. J., in 1922, there was only one type of receiving tube in production. As the electron tube industry expanded, Mr. Dart guided the production of the first thyratron, ignitron, and cathode ray tubes at Westinghouse. In 1952, when the company's Electronic Tube Division was formed at Elmira, he became engineering staff assistant. Later, as patent engineer, he directed the division's activities in securing patents on new developments. Mr. Dart is a member of the AIEE Electronics Committee (1948-49, 1955-61).

Among those who served as individual sponsors for the 1961 National Engineers' Week, February 19-25, are the following: **A. B. DuMont** (F '43), group general manager, Allen B. DuMont Laboratories, Division of Fairchild Camera and Instrument Corporation; **W. L. Everitt** (AM '25, F '36), dean of engineering, University of Illinois; **J. F. Fairman** (AM '20, F '35, HM '55, Member for Life), senior vice-president, Consolidated Edison Company of New York; **Titus LeClair** (AM '24, F '40), manager, nuclear power applications, General Atomic Division, General Dynamics Corporation; and **C. H. Linder** (M '54, F '57), vice-president, General Electric Company. Mr. Everitt has served on the AIEE Broadcasting Committee (1953-61). Mr. Fairman was AIEE president (1949-50), District 3 vice-president (1944-46), and director (1946-49). Mr. LeClair served as AIEE president (1950-51), District 5 vice-president (1946-48), director (1941-45), and on the AIEE Edison Medal Committee (1942-44, 1957-62). Mr. Linder, AIEE president (1960-61), has served as treasurer (1958-60), director (1956-58), and on the Executive Committee (1957-61).

W. M. Edson (AM '54) has been appointed chief engineer and manager of operations of the Central Vermont Public Service Corporation. Mr. Edson had been superintendent of operations since 1937.

A. A. Emlen (AM '28) has been appointed assistant sales manager for Altec Lansing Corporation's Peerless Electrical Products Division, Anaheim, Calif. Mr. Emlen was formerly chief engineer for the division.

Norman Enenstein (AM '50), director of the company's Tactical Systems Laboratory, has been appointed a vice-president of Litton Systems, Inc., a subsidiary of Litton Industries, Beverly Hills, Calif.

David Eng (AM '58), who recently completed the Allis-Chalmers Manufacturing Company's training course for graduate engineers, has been named to a post in the engineering analysis section of the Allis-Chalmers Industries Group, Milwaukee, Wis.

M. D. Ewing (AM '51), manager of area development, Atlantic City Electric Company, Atlantic City, N. J., has been elected second vice-president of the New Jersey Industrial Development Association, a state-wide organization of professional specialists in the field of industrial plant location.

L. H. Faulkingham (AM '40, M '50) has been appointed superintendent of electric operations of the New Bedford Gas and Edison Light Company. He will direct the operations of the Electric Station, Electric Distribution, Electric Engineering and Electric Meter Department.

W. H. Feldmann (M '44), president of Worthington Corporation, has been elected vice-president of the National Association of Manufacturers for the New York-New Jersey Region. He is supervising staff implementation of the association's policies and programs in the bistate area during 1961. In addition, he serves as chairman of the association's international economic affairs committee.

C. R. Fisher (M '58) has been appointed manager of product engineering for Stromberg-Carlson's Telecommunication Division. In his new position, Mr. Fisher is responsible for the development of all new products in the telephone instrument, toll ticketing, and "XY" dial switching equipment lines. He formerly was manager of the Digital Communication Laboratory in Stromberg-Carlson's Research Division. He has served on the AIEE Communication Switching Systems Committee (1959-61) and Data Communication Committee (1959-61).

H. K. Foute (AM '41) has been elected president of Drake Manufacturing Company, Chicago, Ill. Son of the company's founder, A. J. Foute, H. K. Foute started full time as a sales engineer at Drake in 1940. He later became sales manager and then chief engineer. After his father's death in 1950, he became general manager and in 1954 was elected executive vice-president.

J. G. Friedman (AM '46) has been named sales manager in the systems market area for Gulton Industries, Inc., Metuchen, N. J. He joined Gulton last Summer.

John Gammell (AM '38, M '45) has been appointed director, professional development, and **J. T. Graham** (AM '52) as director of graduate training of the Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

D. E. Garr (AM '37, F '51) has been named corporate director of engineering for Raytheon Company, Waltham, Mass. He has resigned as manager of engineering operations for General Electric Company's armament and control section. Mr. Garr was an AIEE vice-president during 1956-58.

R. G. Gentile (AM '50, M '57) has been appointed a research group leader at the Everett, Mass., laboratories of Monsanto Research Corporation, after having served as a research specialist with the special projects department of Monsanto Chemical Company's Research and Engineering Division.

G. E. Gless, Jr. (AM '46), associate professor of electrical engineering at the University of Colorado, Boulder, Colo., has been awarded a faculty fellowship for doctoral studies by the National Science Foundation. In September 1961, he will begin study toward his Ph.D. degree at Iowa State College at Ames. His studies will be in servomechanics and guidance control systems in missiles.

R. M. Godfrey (AM '49), formerly a design engineer, of Howe-Baker Engineers, Inc., a subsidiary of Nalco Chemical Company, Chicago, Ill., was made chief mechanical engineer.

E. I. Green (AM '23, F '46, Member for Life), executive vice-president of Bell Telephone Laboratories, retired on November 30 after a distinguished career of 39 years with the Bell System. Mr. Green has been granted more than 70 patents for his inventions and is the author of many authoritative articles on scientific subjects and on the management and evaluation of technical personnel. He began his telephone career in 1921 with the American Telephone and Telegraph Company's development and research department. There he engaged in transmission studies and the planning of new transmission developments. He took a leading part in the planning of the coaxial system, and made important contributions to the standardization of carrier system frequency allocations. After the merger of the company's development and research department with Bell Telephone Laboratories in 1934, Mr. Green continued his transmission planning activities at the Laboratories. As the United States moved into World War II, he took over broad responsibilities for the development of apparatus, mostly in the microwave range, for the testing of radar systems. Following the war, Mr. Green returned to transmission work for the Bell System and served successively as assistant director of transmission development and as director of transmission apparatus development. In 1953, he was appointed director of military communications systems, with broad responsibilities for both planning and development work in that area. He became vice-president, systems engineering, in 1955, and for the next 3½ years headed that part of the Laboratories organization engaged in the systematic analysis and planning for future developments. Mr. Green assumed the post of executive vice-president in 1959. He is an AIEE director (1959-63) and has served on the following AIEE Committees: Planning and Coordination (1952-60); Publications (1957-60); Education (1958-60); Finance (1959-61); Edison Medal (1959-61); Communication Division (1959-60); Executive Committee (1960-61); Instruments and Measurements (1942-50, chairman 1947-49); Science and Electronics Division (1950-54, chairman 1950-52); and Award of Institute Prizes (1952-56, chairman 1952-54).

Fabian Bachrach

E. I. Green

E. A. Guillemin (AM '24, F '51), Webster professor of electrical engineering of the Massachusetts Institute of Technology, has been named vice-president and director of research of Burnell & Co., Inc., Pelham Manor, N. Y.

H. B. Hansteen (AM '26, F '51), who is on leave from his position as professor of electrical engineering at the City College of New York, has been placed in charge of the Fellowship Program of the International Atomic Energy Agency for the next 2 years, with headquarters in Vienna. The Fellowship Program, supported by 76 United Nations members, established its headquarters in Vienna in 1957. His address is: c/o International Atomic Energy Agency, Kaerntnerring, Vienna I, Austria. Prof. Hansteen is a member of the AIEE Board of Examiners (1957-61).

W. L. Healy (AM '51, M '57) of Drexel Hill, Pa., has been appointed staff engineer of the American Standards Association to work exclusively in the preparation of standards for the Bureau of Ships. Mr. Healy was formerly employed by the General Electric Company from which he retired in November.

M. J. Joncich (AM '51), general sales manager of Datex Corporation, Monrovia, Calif., has been elected vice-president. Mr. Joncich has been with Datex since 1953.

M. H. Kebby (AM '55), formerly commercial products chief engineer of Lenkurt Electric Company, Inc., San Carlos, Calif., has been named project manager of a new group formed to spearhead a stepped-up microwave products development program. Also assigned to this group as a project leader is **M. E. Ferguson** (AM '56).

T. A. Kenny (M '50) has been appointed instrumentation consultant of Curtiss-Wright Corporation, Princeton, N. J. He has taken over the application and sale of Curtiss-Wright recording instruments in the Greater New York area. He had served as product representative for Esterline-Angus in the New York area.

Y. H. Ku (F '45) was re-elected a member of the General Assembly of the International Union of Theoretical and Applied Mechanics, Paris, for the years 1960-64. His new book, entitled "Transient Circuit Analysis," will be published by D. Van Nostrand Company, Princeton, N. J., in the Spring of 1961.

F. E. Kulman (AM '30, M '39), senior engineer with Consolidated Edison Company of New York, Inc., has been elected to the board of directors, National Association of Corrosion Engineers, for a 3-year term.

D. C. Kyker, Jr. (AM '54), electric utility sales representative for the General Electric Company in Atlanta, Ga., has received the Carter L. Redd Award for "outstanding human and professional contributions and unselfish service to his associates and the company." The award consisted of a certificate and three shares of General Electric stock.

S. P. Lapin (AM '48, M '57) has been appointed director of the Industrial Products of Adler Electronics Inc., New Rochelle, N. Y. He joined Adler early in 1960 as assistant to the president. **W. M. Mannel** (AM '54), formerly project manager of the International Standard Electric Company, now directs the newly opened office of Adler Electronics in Asbury Park, N. J., to service Fort Monmouth and the Philadelphia area.

G. E. Lewis (AM '50), former manager of marketing, has become manager of engineering at the General Electric Company's High Voltage Specialty Transformer Section, Holyoke, Mass. **S. T. Maunder** (AM '25, M '34), former manager of engineering, is now advanced engineering consultant. **M. I. Alimansky** (AM '45, M '50), section general manager, has assumed the additional job of acting manager of marketing.

Changes in organization in the electric department of the Public Service Electric and Gas Company, Newark, N. J., are as follows: **F. P. Librizzi** (AM '44), formerly chief electrician, Essex Generating Station, Newark, has been named master mechanic, Marion Generating Station. **W. H. Van Zee** (AM '41), previously engineer, electric distribution department, has become senior engineer, General Office. Mr. Van Zee has served on the AIEE Power System Communications Committee (1960-61). **H. W. Grissler** (AM '46, M' 56), previously assistant to the electrical engineer, electric engineering department, has been named assistant electrical engineer, General Office. **R. A. Huse** (AM '40, M '51), formerly senior engineer, electric engineering department, has been named assistant to the electrical engineer, General Office. **Paul Barth** (AM '53), formerly engineer, electric engineering department, has been named senior engineer, General Office.

D. C. Luce (AM '36, F '49), president, Public Service Electric and Gas Company, and **W. O. Turner** (AM '31, M '51), chairman of the board, Louisiana Power & Light Company, are among the committee members appointed to guide the newly established Research Division of the Edison Electric Institute.

Harold Lyons (M '47) has joined the staff of Electro-Optical Systems, Inc., as a vice-president and will manage the company's newly formed Quantum Electronics Division. In his new position, Dr. Lyons will be responsible for extending present company capabilities in the field of coherent light, with particular emphasis upon development of masers, lasers, and irasers. He was formerly head of the atomic physics department and senior scientist at Hughes Research Laboratories.

Jesse Marsten (AM '26, M '50), senior vice-president of International Resistance Company, retired December 31, 5 months after marking his 30th anniversary with the company. In recent years, Mr. Marsten was in charge of the firm's foreign operations and affiliates. His other positions with the company have included research and engineering, contract administration, and supervision of patents.

J. V. McGuire (AM '47, M '59) has been appointed general manager of the Allis-Chalmers Manufacturing Company's Pittsburgh Works. He succeeds **D. A. Griffith** (AM '39, M '49), who had served in the post since 1954.

R. C. Mildner (AM '34), former chief technical officer of Telegraph Construction and Maintenance Company, Ltd., of Greenwich, England, has joined the plastics department of the Dow Chemical Company as a technical specialist in dielectric insulation for power and communication cables.

Sid Mitwol (AM '49) has been appointed vice-president of the Meaker Company, a subsidiary of Sel-Rex Corporation, Nutley, N. J. Mr. Mitwol, who has been general manager, Rectifier Division, for the past year, will continue in this function as vice-president and general manager, Electrical Division, Meaker Company.

R. W. Olmsted (AM '52) has been promoted to vice-president of marketing at Magnetics Inc. He started at Magnetics in 1953 as a sales engineer.

R. E. Othmer (AM '51) has been appointed an engineering section head of FXR, Inc., Woodside, N. Y. He will direct development of electronics test equipment for microwave measurement. He did similar work for Narda Microwave Corporation.

M. F. Peters (M '44) has been appointed director of the accelerated Research and Development program of Breeze Corporations, Inc., Union, N. J.

W. L. Peterson (AM '38, M '46) has been appointed assistant manager of the motor and generator department and **R. E. Horn** (AM '52) has been named acting manager of the regulator department of the Allis-Chalmers Manufacturing Company's Power Equipment Division. Mr. Horn has served on the AIEE Aero-Space Instruments Committee (1957-61).

H. F. Pierce (AM '39, M '49), a member of the firm of Maurice H. Connell & Associates, Miami, Fla., has been presented with a citation from the U. S. Army Corps of Engineers for his vital work in the complex missile facilities at Cape Canaveral and Patrick Air Force Base. Mr. Pierce also has been nominated by the National Society of Professional Engineers to serve as vice-president of the Southeastern Area for the administrative year which begins in July 1961. He has served on the AIEE Professional Conduct Committee (1957-61).

Haraden Pratt (AM '15, F '37), engineering consultant, and **Ferdinand Hamburger, Jr.** (AM '26, F '48), professor and chairman of the department of electrical engineering, Johns Hopkins University, were re-elected to the offices of secretary and editor, respectively, by the Institute of Radio Engineers' Board of Directors to serve on the Board in 1961 for a 1-year term. Both officers also serve as directors. **A. N. Goldsmith** (M '15, F '20), consulting engineer and editor emeritus of IRE, was re-elected as director. Mr. Hamburger has served on the AIEE Instrumentation Division Committee (1956-61, chairman 1960-61) and Technical Operations Department Committee (1960-61).

A. E. Pringle II (AM '36, M '51) of Philadelphia, Pa., president of the Pringle Electrical Manufacturing Company, was elected treasurer for the coming year of the National Electrical Manufacturers Association at the 34th annual meeting of the association on November 17. He was also elected to the association's Board of Governors for the term ending 1963. Appointed to the Board of Governors for 1-year terms were: **H. T. Brinton** (AM '23, Member for Life), president, Phelps Dodge Copper Products Corporation, New York, N. Y., and **E. S. Ruth** (M '36, F '45), director of engineering, Gamewell Company, Newton Upper Falls, Mass. Mr. Pringle has served on the AIEE Industrial and Commercial Power Systems Committee (1952-61) and Standards Committee (1955-61).

H. C. Reasoner (AM '53, M '59) has been named director of the Detroit Edison Company's general engineering department. **S. W. Luther** (AM '48, M '54) has been promoted to assistant director, and **K. H. MacLean** (AM '53), to chief of the System and Stations Division. Mr. Reasoner and Mr. Luther joined Detroit Edison in 1928. Mr. MacLean came to Detroit Edison in 1927.

H. P. Roberts (M '49) has been named general manager of the Siegler Corporation's Space System Technology Group, Inglewood, Calif. Before coming to Siegler, Mr. Roberts was manager, test support department, Systems Engineering Division, Space Technology Laboratories, Los Angeles, Calif.

J. W. Robinson (AM '37, M '47), president and board member of Leeds & Northrup, Canada, Ltd., and a vice-president of the parent company, Leeds & Northrup Company of Philadelphia, Pa., has been appointed to the additional post of joint managing director of Leeds & Northrup, Ltd., Birmingham, England, and will make his headquarters there.

R. C. Roe (AM '18, F '33, Member for Life), founder of Burns and Roe Inc. and its board chairman, has been named chairman of the newly formed Brill Engineering Corporation. **K. A. Roe** (M '55) has been elected vice-president of the corporation.

Mark Rosen (AM '58), formerly chief engineer at U. S. Relay-Electronics, has joined Datex Corporation, Monrovia, Calif., as development engineer.

R. A. Rugge (AM '30, M '36) has been appointed director of engineering for

Kollsman Instrument Corporation. Mr. Rugge will direct both the design and development programs and supervise the Engineering and Product Engineering Laboratories. Prior to his appointment with Kollsman, Mr. Rugge was vice-president and director of the W. L. Maxson Corporation. He has served on the AIEE Aero-Space Transportation Committee (1944-61).

"Oozlefinchling" Certificate Presented

INDUCTED into the "Ancient and Honorable Order of the Oozlefinch" was (*left*) H. A. Tynan (AM '50), electric system manager of the San Antonio, Texas, City Public Service Board, at a reception held recently at the Fort Bliss Officers Mess which concluded an orientation on the U. S. Army missile program for select business and civic leaders from San Antonio and southwest Texas. Mr. Tynan received congratuations and the "24-hour Oozlefinchling certificate" from (*right*) Brig. Gen. S. M. Mellnik, assistant commandant, Army Air Defense School, Fort Bliss, Texas. The 12-man group which participated in the orientation were guests of Headquarters Fort Sam Houston.

U. S. Army Photo

H. L. Schmidt (AM '58) has been appointed an engineer in the Plant Engineering Division of Argonne National Laboratory, Argonne, Ill. In his new position, he will be working on electrical design for the Experimental Breeder Reactor-II, now under construction at Argonne's Idaho Falls, Idaho, site. Mr. Schmidt was formerly an electrical designer at the Pioneer Service & Engineering Company, Chicago, Ill.

Ted Shamshoian (AM '52) has joined the sales engineering staff of Luscombe Engineering Company, Pasadena, Calif.

L. P. Shelley (AFFIL '55), company vice-president previously in charge of Federal Pacific's plant operations in Santa Clara, Calif., will head the Western Manufacturing Group of the Federal Pacific Electric Company.

G. E. Spaulding, Jr. (AM '54) has been elected to the newly created post of vice-president in charge of engineering operations, Photo Products Division, Bell & Howell Company, Chicago, Ill. Mr. Spaulding was formerly associated with the Electric Autolite Company, Toledo, Ohio.

R. C. Sprague, Jr. (M '40, F '49) has been promoted to senior vice-president, industrial relations, of Sprague Electric Company, North Adams, Mass. **C. G. Killen, Jr.** (AM '42) has been advanced to vice-president, industrial and military sales, of the company. Mr. Sprague was formerly director of industrial relations. Mr. Killen served as manager of field engineering for the last several years.

I. M. Stein (AM '18, F '39, Member for Life), president of Leeds & Northrup Company, Philadelphia, Pa., has been elected president of the Foundation for Instrumentation Education & Research for the year 1961. Dr. Stein has served on the following AIEE Committees: Sections (1929-41, chairman 1933-36); Publication (1934-42, chairman 1936-40); Special Committee to Revise Section Territory (chairman 1935-37); Constitution and Bylaws (1938-46, chairman 1941-44); Lamme Medal (1941-44, 1957-60); and Collective Bargaining and Related Matters (Special Committee 1944-48, chairman 1944-48).

R. J. Stone (AM '52) has been named to the new position of research and development supervisor in the delay line section of Corning Glass Works, Corning, N. Y.

J. C. Strasbourger (AM '31, M '40) has been elected president of the Lift-a-Loft Corporation, Muncie, Ind. Mr. Strasbourger has served as vice-president of AIEE District 2 (1951-53), director of District 11 (1953-61), a member of the AIEE Board of Directors (1956-61), and the Planning and Co-ordination Committee (1960-61).

Henry Swift (AM '54) has been appointed assistant director of the infrared laboratory at Hughes Aircraft Company's Santa Barbara Research Center. Dr. Swift has been a member of the center's technical staff for 4 years.

Gordon Thompson (AM '12, F '46, Member for Life) has been named vice-president and technical director of Electrical Testing Laboratories, Inc., New York, N. Y. He was formerly vice-president and chief engineer. Mr. Thompson has served on the AIEE Board of Examiners (1948-61). **E. H. Salter** (AM '23, F '51, Member for Life), who succeeded Mr. Thompson as chief engineer, started at the laboratories in 1924. **R. J. Amorosi** (AM '49), formerly president of Parameters, Inc., has been appointed assistant to the chief engineer of the laboratories.

C. K. Titus (AM '57) of Baltimore, Md., has joined the staff of the Communications and Data Processing Division of the Collins Radio Company. Mr. Titus was appointed manager of the scientific analysis and programming department.

A. C. Todd (M '54), a specialist in electronic instrumentation, has joined the Hallicrafters Company as director of applied research for military products. Dr. Todd was previously a staff member at the Illinois Institute of Technology's Armour Research Foundation.

S. N. Vavoudis (AM '52) has joined United Aircraft Corporation's Norden Division as supervisor of the environmental laboratory. Mr. Vavoudis came to Norden from Itemlab Inc., Port Washington, L. I., where he was director of engineering.

C. B. Wakeman (AM '53) has been named vice-president of research and development at Magnetics. Dr. Wakeman came to Magnetics as a research engineer in 1955. He has served on the AIEE Magnetic Amplifiers Committee (1957-61).

E. A. Walker (AM '34, F '47), president of the Pennsylvania State University, has been elected to the Board of Directors, Melpar, Inc., a subsidiary of WABCO, of which Dr. Walker is a member of the Board of Directors. He has served as AIEE representative to the Engineers' Council for Professional Development (1958-61).

J. K. Walker (AM '58) has joined Packard Bell Electronics Corporation as director of product planning for the Defense and Industrial Group. Mr. Walker was formerly director of marketing and engineering at General Precision Equipment Controls, Inc., and director of marketing at Librascope, both subsidiaries of General Precision Equipment Corporation.

H. A. Weber (AM '49, M '55) has been appointed director, programming and Control Division, in the Office of Manufacturing of the Atomic Energy Commission's Albuquerque Operations Office, Albuquerque, N. Mex. The Plant Operations Division, which Mr. Weber has directed since December 2, 1957, has been abolished.

W. F. Wetmore (AM '36, F '55), director of the Detroit Edison Company's general engineering department, has retired after 33 years of service with the company. He started with Detroit Edison as an electrical engineer in 1928 and worked as system and stations engineer and chief electrical engineer before being named head of general engineering in 1954.

H. A. Wheeler (F '46) of Great Neck has been appointed to the Department of Defense Advisory Group on Radar. Mr. Wheeler is a vice-president and director of Hazeltine Corporation, as well as president of Wheeler Laboratories, Inc.

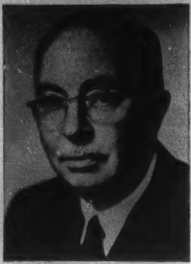
F. G. Willey (AM '38) has been appointed manager of infrared systems, Radio Corporation of America. Mr. Willey joined the engineering department of the Missile Electronics and Controls Division in 1959 as manager, Subsystems Development.

R. R. Wylie (M '46) has been elected a vice-president of the Sangamo Electric Company, Springfield, Ill. His present assignment is vice-president—manager of electronic products sales. He joined Sangamo in 1957. **R. C. Lanphier, Jr.** (M '49) was named to a newly created senior vice-president office. Mr. Lanphier was appointed director of sales in 1957.

OBITUARIES

Charles R. Hazard (AM '35), district manager for Line Material Industries at Portland, Oreg., since 1935, died December 20 at the age of 60. Born September 6, 1900, in Clarence, Iowa, he was educated at Iowa State College where he received the B.S. degree in electrical engineering in 1924. Prior to his association with Line Material, he was employed by the Public Service Company of Northern Illinois for 12 years. Mr. Hazard was a member of the Illuminating Engineering Society and the Electric Club of Oregon.

John Vincent Lawless Hogan (AM '11, M '20, F '54, Member for Life), inventor of single dial radio tuning and co-founder of radio station WQXR, died December 29. Born February 14, 1890, in Philadelphia, Pa., he attended the Sheffield Scientific School at Yale University during 1908-10, where he took honors in physics and mathematics. Mr. Hogan started to experiment with television in the 1920's. Over an experimental frequency, W2XR, he began broadcasting a sound program in 1928 to match a visual program. In 1936, he was joined by E. M. Sanger, and they organized the Interstate Broadcasting Company to operate W2XR as WQXR. When the *New York Times* purchased the station in 1944, Mr. Hogan continued to serve for the next 6 or 7 years in an advisory capacity, but his main interest was in the development of facsimile transmission over radio waves. He developed a radio facsimile machine that produced a 4-column newspaper, with pictures and advertisements, at the rate of 500 words a minute. His career began in 1908 when he took a job as chief laboratory assistant to Dr. Lee de Forest, who had just invented the vacuum tube, the heart of modern radio. When Dr. De Forest made the first grid audion, Mr. Hogan made the first quantitative study of the plate current characteristic of a grid triode. In 1909, he was employed by the National Electric Signalling Company. Mr. Hogan was a co-founder of the Institute of Radio Engineers in 1912, effected through the consolidation of the Wireless Telegraph Engineers and the Wireless Institute. That year, he superintended the erection of the Bush Terminal Station in New York City. In 1913, he had charge of acceptance-test operations between the Navy's first high-power station at Arlington, Va., and the *U.S.S. Salem.* In 1921, Mr. Hogan went into business for himself as a consulting engineer, and began a long series of experiments in television, FM radio, and facsimile transmission. During World War II, Mr. Hogan devoted himself to communications problems in conjunction with the National Defense Research Committee, the Army Signal Corps, and the Army Air Forces. He also served as special assistant to Dr. Vannevar Bush, director of the Office of Scientific Research and Development. In that period, he was principally concerned with radar, guided missiles, and the proximity fuse. After the war, he continued his experiments in facsimile transmission.



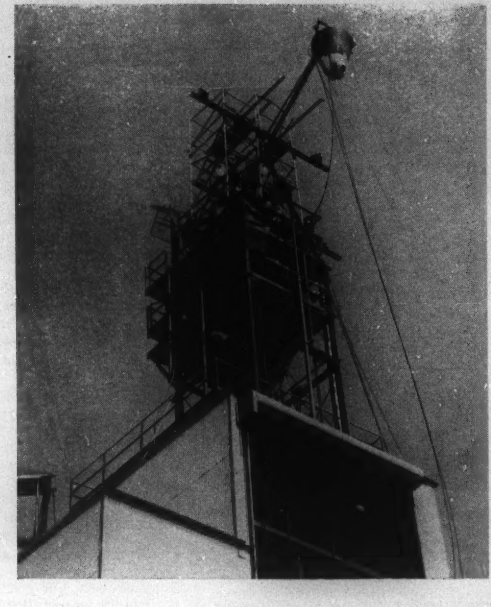
J. V. L. Hogan

Harry Prentice St. Clair (AM '22, M '29, F '44, Member for Life), retired consulting engineer for the American Electric Power Service Corporation of New York, died recently. He was born December 2, 1895, in LaVerne, Calif. In 1920, he received the B.S. degree in electrical engineering from the California Institute of Technology. Mr. St. Clair was employed by the General Electric Company during 1920-24, until he joined the American Electric Power Service Corporation, then known as the American Gas and Electric Service Corporation, in 1924. An expert on high voltage transmission, he planned 76,000 miles of power lines that serve 2,300 communities in Indiana, Michigan, Ohio, Virginia, West Virginia, Kentucky, and Tennessee.

Harvey William Sattler, Jr. (AM '52), engineer in the Test and Energization Section of the Bonneville Power Administration, Portland, Oreg., died October 30. He was born September 7, 1927, in St. Louis, Mo. Prior to entering the U. S. Army Corps of Engineers in 1945, he was employed by the American District Telegraph Company and the Presstite Engineering Company. While in military service, he supervised the warehousing and installation of electric equipment at Fort Belvoir, Va. He graduated from Washington University of St. Louis in 1951 with the B.S. degree in electrical engineering. In 1951, Mr. Sattler was employed in the Subsection Construction Section of the Bonneville Power Administration. While an office engineer and project engineer for the construction of new substations in this Section, he completed special training on welding and metal-joining, paint inspection, and advanced concrete control. In 1955, he was granted a joint award which pertained to the installation and mounting of lighting arrestors in feeder-type substations. Since 1956, he had been with the Test and Energization Section of the Bonneville Power Administration where his work included the testing of oil circuit breakers, transformers, and all other electric equipment used in substations.

Erwin A. Wright (AM '29, M '59), assistant superintendent of the electrical department for the E. I. du Pont Company at the Savannah River Atomic Energy Plant, Aiken, S. C., died December 28, 1960. He was born October 5, 1901, in League City, Texas. During 1922-28, he was employed by the Gulf Production Company in Texas. For the next 6 years, he worked in Venezuela as an electrical superintendent for the Venezuelan Gulf Oil Company on Lake Maracaibo. Mr. Wright was employed by Westinghouse Electric International Company in New York in 1937 as supervisor of oil and mining industry sales. He joined du Pont in 1941 as an electrical superintendent at the Indiana Ordnance Works, Charleston, Ind., and held similar posts at the Alabama Ordnance Works at Childersburg and the Kankakee Ordnance Works in Illinois. During World War II, he was an engineer in the Navy with the rank of lieutenant commander. Mr. Wright was an electrical engineer for the Reed Roller Bit Company, Houston, Texas, during 1946-47. He was a regional engineer for Westinghouse Electric International in 1947-51 on projects which include a Turkish Airport and the Exposician Bi-Centenaire du Port-au-Prince in Haiti. In 1951, he was employed by du Pont at the Savannah River Plant in Aiken as an assistant superintendent in the electrical department.

OF CURRENT INTEREST



RE-ENTRY BODY attached to separation cone atop the test stand ready for the Discoverer re-entry body drop test at Lockheed's Santa Cruz Test Base. Note camera mounts on I beams. Cover photo shows re-entry body the instant following separation from the ejection cone.

Camera Solves Discoverer Recovery Problems

THE unprecedented speed with which the state of the art in the spacecraft and missile field is progressing has imposed what amounts to an around-the-clock alert for all hands involved in the various United States defense programs. This is an "invent-to-order" business and, more often than not, demands "on-the-spot inventing and improvising" within tolerances unheard of in other industries.

The companies who have been assigned the responsibilities for developing the nation's space and missile programs are operating at the very edge of man's expanding knowledge and are constantly faced with unforeseen problems for which there are no precedents. With thousands of subsystems in each vehicle, these problems have to be solved with what amounts to split-second timing to avoid a bottleneck for the whole system. Moreover, the problem solving "ogre" has been amplified many times by the acceleration of production schedules imposed by military requirements.

CLOSE-UP of camera installation on I beam projecting from test stand.

Modern photographic techniques have played a major role in this fast-breaking game. A dramatic instance of this use of the camera as a tool of modern research is contained in the story behind the recent flight of Discoverer XIII involving the recovery of the first man-made object from orbit around the earth.

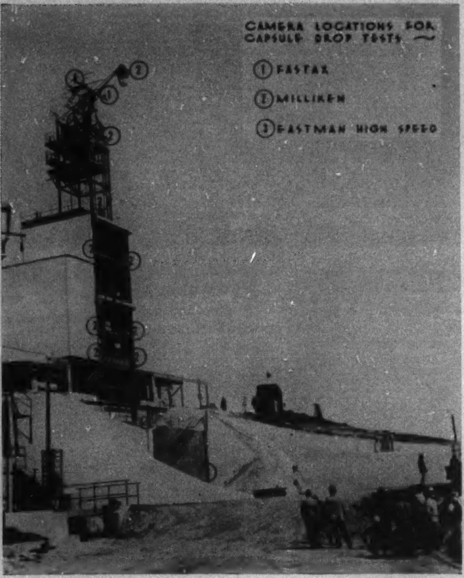
The Agena satellite, developed and built by the Lockheed Missiles and Space Division, Sunnyvale, Calif., for use in the U.S. Air Force Discoverer and Midas programs, and the National Aeronautics and Space Administration (NASA) earth orbiting and far space probes, is without doubt the heaviest and most sophisticated all-purpose space vehicle in the free world today. It has been aptly called a "space truck," because of its capability of being modified or especially instrumented to carry out virtually any space mission of the foreseeable future.

As the Agena was progressively proved out in the Discoverer series, one of the primary capabilities that had been designed into the vehicle was approaching its turn at bat. During the first 11 flights of the Discoverer, basic vehicle design was verified, certain problems were identified and solved, and system reliability on orbit established. Lockheed and the Air Force then selected Discoverer XIII as the satellite that would be devoted to the all-out effort of proving the full capability of the system; precise polar orbit, attitude stabilization and control on orbit, response to ground and self-contained programmed control, and capsule ejection, re-entry, and recovery.

The vehicle was heavily instrumented with a diagnostic payload that would monitor every aspect of the satellite's performance. Previous flight data, however, indicated that trouble might be expected in the action of the re-entry body itself after separation from the Agena. To reduce the likelihood of such an occurrence, it was decided to simulate the sequence of de-orbiting and re-entry by dropping a series of flight configuration capsules from a jury rig atop one of Lockheed's static test stands at its remote test base in the Santa Cruz mountains, and fortify these findings with another series of tests on a specially designed and built air-bearing test bed.

The Santa Cruz Test Base's Photographic Instrumentation Unit was handed the data-acquisition assignment. On only 5 days' notice, they had to rig the test area for photographic coverage from every angle and level. The product of their efforts was to provide calibrated photographic coverage for base time reference of rocket ignition, burning times, spin rate, de-spin rate, residual spin rate, capsule attitude throughout free fall, and surveillance of the separation sequence. Accuracy of the film data had to hold to less than 1% error.

Armed with the exact distance of free fall and a time schedule for the critical events, precise points in the drop path at



LOCKHEED Missiles and Space Division static test stand in the Santa Cruz Mountains, Calif., showing modifications and camera sights for the Discoverer re-entry body drop tests.

which each event would occur were established. Two camera mounts were prepared at each of these levels. Camera locations were accurately pin-pointed by transit reading to assure that all cameras involved in the test were equidistant from the drop path and at the same angular separation. With similar accuracy all camera mounts were carefully leveled on two axes.

This setup covered all programmed events, but left gaps in the coverage of the total flight path. It was assumed however that any changes in the capsule's attitude between these points would be linear and could be plotted as extensions of the curves taken at the moment of accelerating force.

In this connection, it should be noted that while the over-all accuracy had to be within the 1% tolerance, specific readings required more critical delineation—capsule attitude data had to be ±0.25 degree, and spin rate ±0.1 rpm.

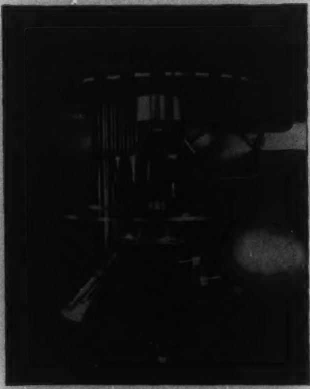
The co-ordination of the series of paired cameras proved extremely valuable in the final data reduction in that it allowed a single composit plot to be made for the whole drop without distortion due to different camera angles. Moreover, the paired-camera-type coverage provided accurate data on attitude change that could be plotted for any axis regardless of the capsule's position.

Additionally, three cameras were mounted in the separation vehicle directly above the capsule's drop path. These recorded the spin, de-spin, residual spin, and rocket burn rates.

As back-up instrumentation for the paired cameras, two cameras were ground mounted below the impact point at the same angular separation and distance from the path. Back-up for the three spin-rate cameras was provided by a single ground mount located below the impact point.

For over-all surveillance and third echelon back-up, two cameras were fitted with telephoto lenses and ground mounted some distance from the path and at the same angular separation as all other cameras. These last two were manual tracking units.

The top pair of cameras were Fastax WF4's operating at approximately 4,000 fps, the remaining paired cameras were Millikens. The two pairs immediately below the Fastax's were operated at 200 fps and the lower two at 400 fps, providing exposure times of 1 millisecond and 0.5 millisecond, respectively. The tracking camera operated at 64 fps.



AIR BEARING test bed during actual operation. The striped disc-shaped counter weight secured to the top of the bowling ball air bearing provided the photographers with an exact plot of axial deviations during test. The test vehicle showing reaction jets is rigidly suspended from the bottom of the bearing.

Color film was used in all cameras in this series of tests in order that the rocket ignitions and shutdowns could be readily recognized and the colored quadrants on the capsule itself be accurately charted. All cameras were equipped with timing lamps and a 17-digit binary code was fed onto one side of the film during operation. Sixty-pulse-per-second (pps) timing was recorded on the other side of the film as back-up. These timing codes provided exact time calculations between cameras.

Some 15,000 feet of film were exposed during the four drop tests. Because of the short lead time, film analyzer was not available, so data reduction presented something of a problem. Quick-look data was obtained by measuring projected images and plotting the colored quadrants.

The formal data was obtained by projecting through a ground glass screen. Knowing that the frame line on the Millikens was well within acceptable tolerances of true horizontal, a drafting machine was mounted behind the screen to provide a cross-hair reference and a 90-degree angle was used to establish the vertical.

By taking the center frame of the sequence showing the capsule passing through the field of view, an image was obtained that was on the optical centerline of the lens and an attitude point could be read without distortion. By reference to the 17-digit timing, the matching frame from the opposing camera could be identified. Data thus obtained was plotted in terms of capsule angle of rotation vs. time, capsule spin rate vs. time, and capsule angle of deflection from true vertical vs. drop distance from point of separation.

This complex test setup provided a high degree of reliability throughout all the tests, and the sum total of data obtained was highly satisfying. More important, the predicted problems with the ejected capsule did present themselves. They were immediately identified and engineered out of the system.

The second phase of the test was to obtain a continuous pictorial record of one specific sequence of events that could have a bearing on the capsule attitude throughout de-orbiting. This required a static test bed equipped with a virtually friction-free air bearing to support the counterbalanced capsule.

Lockheed considers this air bearing mount a masterpiece of ingenuity which illustrates the type of inventive genius that has saved literally millions of dollars of the taxpayers money. To machine a spherical bearing would have been costly in both time and money. The Lockheed engineers' answer was an ordinary bowling ball. The bowling ball bearing was worked into the race with an ordinary abrasive compound and the result approached perfection. A low-pressure air cushion was created between the ball and race by the introduction of compressed air through a series of small holes in the face of the bearing race.

The test cone was suspended rigidly

from the bottom of the ball bearing and a counterweight fixed to the top. In this manner, the photographic unit was able to record the action of forces imparted to the capsule in a friction-free situation, yet have a static test bed.

Two cameras were mounted above this fixture to record the top of the counterbalance, which was painted with alternating red and white stripes. One of these cameras used color film and the other black and white. Two cameras were mounted to the side, equidistant and at a 90-degree angle from the test vehicle. Directly beneath was a fourth camera focused upward to observe the vehicle deviations on its vertical axis.

All cameras operated at 200 fps (exposure time—1 millisecond) and recorded 1,000-pps and 60-pps timing. Time correlation between cameras was accomplished by interrupting the 1,000 pps after the cameras were running. As back-up time reference, a flash bulb was fired by the same electric impulse that started the actual test. The bulb was in the field of all cameras.

To provide a reference graph with which to compare actual test results, the test vehicle was tilted physically at 1-degree intervals and 1-frame exposures made. This series was plotted on a polar plot and used as calibration for the tests.

The actual test film was then projected onto this polar plot and the center point of the counterweight plotted for each frame. The resultant points, when connected by lines gave a graphic picture of deflection, rotation, and time intervals.

To maintain tolerances in the air bearing, the tests were conducted in a temperature-controlled room. This critical temperature control necessitated the absolute minimum in radiant heating from light sources. This was accomplished by using a Color-Tran lighting system which allowed all lights to burn at a very low voltage until cameras reached speed and triggered the system to high intensity light.

The air bearing tests were conducted on a frequency of one every 5 hours. Data from each test had to be processed for "quick look" before each succeeding test. For this reason black and white film with hand processing was used. **EE**

Microminiature Timers Driven by Aspirin-Size Motor

A Lilliputian motor is the power source for equally small elapsed time indicators and repeat cycle timers, The A. W. Haydon Company, Waterbury, Conn., manufacturers of the microminiature trio announced.

Small enough to be hidden behind an ordinary thumbtack, the 115-volt 400-cps single-phase hysteresis-type motor measures $\frac{3}{8}$ inch in diameter by $\frac{9}{32}$ inch in length, and consumes less than $\frac{1}{2}$ watt of power. The torque of the motor is rated at 1.5×10^{-6} hp (0.0005 ounce-inches), and its weight is given as $\frac{1}{6}$ ounce.

Company engineers stated that the motor would be especially useful for instruments and computers, actuating selector switches, tape handling and process timing.

The motor was specifically developed, however, to power a hermetically sealed repeat cycle timer measuring $\frac{1}{2}$ by 1 by 1 inch. Three roller switches in the timer are driven at 1 rpm by the motor, while the switches in the device are rated for 7 amperes resistive at 28 volts d-c and 5 amperes resistive and inductive at 115/230 volts a-c, 60 cycles.

Designed for repeated switch control functions where space and weight considerations are primary, the 1-ounce timer can be used in airborne computers to pulse or program circuits, or in any conventional timer application, as for example telemetering, programming of circuits, or any application utilizing a time base. It is said to have an outstanding resistance to severe environmental conditions.

The second device powered by the "fleapower" motor is the smallest practical digital elapsed time indicator ever manufactured, according to the company. The 4-digit indicator measures only $\frac{1}{2}$ inch square by $1\frac{1}{16}$ inch long, and operates from a frequency of 400 cps. Weighing $\frac{3}{4}$ ounce, the instrument comes in two models: one reading tenths of hours, and the other registering hours. Both employ 4-digit drum-type counters having a range of 999.9 and 9999 hours, respectively. The white numerals on a lusterless black background offer excellent readability—even at a glance—despite the tiny size, simplifying reading problems and eliminating errors associated with dial face indicators. **EE**

MADE IN U.S.A. BY
THE A.W. HAYDON COMPANY
WATERBURY, CONNECTICUT
HOURS AND TENTHS
1 2 3
HOURS AND TENTHS

TOP PHOTO: Trio of microminiature devices manufactured by The A. W. Haydon Company: repeat cycle timer (*left*), motor (*center*), and digital elapsed time indicator (*right*). Bottom photo: Digits on the elapsed time indicator can be read much easier than conventional dial face indicators.

Future Meetings of Other Societies

ISA, 11th Annual Conference on Instrumentation for the Iron & Steel Industry, Mar. 8-10, Roosevelt Hotel, Pittsburgh, Pa. R. R. Webster, Jones & Laughlin Steel Corp., Research Laboratory, 900 Agnew Ave., Pittsburgh 30, Pa.

2nd Symposium on Engineering Aspects of Magnetohydrodynamics, Mar. 9-10, University of Pennsylvania, Philadelphia, Pa. Institute of Radio Engineers, 1 E. 79th St., New York 21, N.Y.

3rd Annual Industry Missile and Space Conference, Mar. 10-12, Cobo Hall, Detroit, Mich. Michigan Aeronautics and Space Association, 901 Book Bldg., Detroit 26.

ASME Aviation Conference, Mar. 12-16, Statler Hilton Hotel, Los Angeles, Calif. The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N.Y.

National Association of Corrosion Engineers, Annual Conference & Corrosion Show, Mar. 13-17, Statler Hotel, Buffalo, N.Y. Air-Conditioning & Refrigeration Institute, 1346 Connecticut Ave., N.W., Washington 6, D.C.

EIA, Spring Conference, Mar. 15-17, Statler Hilton Hotel, Washington, D. C. Electronic Industries Association, 1721 DeSales St., N.W., Washington 6, D.C.

IRE, International Convention, Mar. 20-23, Waldorf-Astoria Hotel and New York Coliseum, New York, N.Y. Institute of Radio Engineers, 1 E. 79th St., New York 21, N.Y.

American Nuclear Society—North Texas Section, Symposium, Statler-Hilton Hotel, Mar. 28-29, Dallas, Texas. O. J. Du Temple, 86 E. Randolph St., Chicago 1, Ill.

PIB, Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma, 11th Annual International Symposium, Apr. 4-6, Auditorium of the Engineering Societies Building, 33 W. 39th St., New York 18, N.Y. Symposium Committee, Polytechnic Institute of Brooklyn, 55 Johnson St., Brooklyn 1, N.Y.

ASTM, Symposium on Materials and Electron Device Processing, Apr. 5-7, Benjamin Franklin Hotel, Philadelphia, Pa., American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Institute of Environmental Sciences, Annual Meeting and Equipment Exposition, Apr. 5-7, Sheraton Park Hotel, Washington 8, D. C. Same. P. O. Box 191, Mt. Prospect, Ill.

Overseas

10th Electrical Engineers Exhibition, Mar. 21-25, Earls Court, London. Electrical Engineers (ASEE) Exhibition Ltd., 6 Museum House, 25 Museum St., London, W. C. 1, England.

The Engineering, Marine, Welding & Nuclear Energy Exhibition, Apr. 20-May 4, London. A. Seligman, 9 Malcolm Rd., London, S.W. 19, England.

1st International Television Festival, May 15-27, Montreux, Switzerland. Mark Associates International, 501 Madison Ave., New York 22, N.Y.

IMEKO Conference, June 26-July 1, Engineering Societies Building, Budapest, Hungary. J. Johnston, Jr., President of ISSA, Dupont de Nemours, Wilmington 98, Del. or IMEKO Secretariat, Budapest 5, P.O.B. 3.

United Nations Conference on New Sources of Energy, Aug. 21-31, Rome, Italy. A. G. Katzin, Executive Secretary, United Nations Conference on New Sources of Energy, United Nations, New York, N.Y.

Rassegna Internazionale Elettronica, Industrial and Commercial Exhibit, Aug. 21-31, Via della Scrofa 15, Rome, (Organized by "Rassegna"—not United Nations or the Italian Government). Same.

Brightly Lighted Room Helps Unveil Mysteries of Plant Growth

AT THE U.S. Department of Agriculture (USDA) research center, Beltsville, Md., is a basement room newly lighted to a higher level than normally is encountered by man except in bright sunshine. It is helping researchers unveil the mysteries of plant growth.

"We don't know how much light is needed for optimum plant growth," said USDA Chief Physiologist H. A. Borthwick, "but we do know that plants grown in this room are superior to those grown in our other rooms having lower light levels." Other important factors include the color of light and the length of time plants are exposed to it.

The new 9- by 16-foot room offers plant growth scientists up to three times as much light with which to experiment as exists in other plant growth rooms at the Beltsville Plant Industry Station. In early tests, scarlet sage seedlings flowered much faster than in other plant growth rooms and in greenhouses, according to Dr. Borthwick.

To get the high levels of light—initially 5,000 footcandles, or more than 100 times as much as prevails in the average office—government scientists selected as their chief light source General Electric's 8-foot-long Power Groove fluorescent lamps. Sixty-four of the lamps literally blanket the 7-foot-high ceiling. They are operated on a new circuit which assures maximum light output.

The fluorescent tubes are supplemented by forty 100-watt incandescent bulbs. The ratio of incandescent to fluorescent light has a bearing on what a plant will do with respect to growth, according to Dr. Borthwick. He explained that recent experiments with these light sources contributed importantly to the discovery of a light-sensitive compound in all plants which controls their development.

"Installation of plant growth rooms is proceeding at a tremendous rate," Dr. Borthwick said. He pointed out that virtually every college and university, in addition to Department of Agriculture Research and Experiment Stations, is now either operating or planning one or more growth rooms. In some institutions extensive installations (phytotrons) consisting of a number of growth rooms with elaborate controls, are planned or under construction.

In addition, many industries are operating or planning growth rooms to test the growth characteristics of seeds and plants in various environmental conditions, the effectiveness of fertilizers, weed killers, anti-insect chemicals, disease inhibitors, and others.

Besides the larger rooms, thousands of lighted commercial and home-made growth chambers and cabinets are used by organizations and hobbyists.

What is exciting plant physiologists today is the possibility that they now have the key to a man's complete control of plant growth from seed germination through plant flowering and fruiting. Discovery of the triggering mechanism for plant development is hailed by the Department of Agriculture as one of the most important research achievements in 25 years.

A light-sensitive substance in plants, determined to be two forms of a blue pigment which exists in plants in amounts of one part in a million, has been found to control plant growth responses.

The two forms of the pigment, according to Dr. Borthwick, act as valves which open or close according to the kind of light they receive. Further research will be aimed at isolating, purifying, and identifying the growth-triggering substances.

Scientists first determined the presence of such a compound when they studied the effect of different colors of light on plant responses. They found that red light prevents flowering of some kinds of plants, promotes flowering of others, and reduces stem elongation. It also promotes the germination of seeds and production of red coloring in plant parts.

Each effect of the red light, however, is nullified or reversed by exposure to "far-red" light. Far-red is the short wave length of the infrared spectrum. It immediately adjoins the red part of the visible spectrum. Incandescent lamps emit far-red light in large quantities.

The scientists verified the presence of the pigment by examining plant juice under a spectrophotometer. After the extract was first irradiated with red, the spectrophotometer indicated high absorption in the far-red, and after strong irradiation with far-red the region of absorption shifted back to the red.

Exposure of seeds, fruit, and plants to red and far-red light in plant growth chambers has caused responses as follows:

Germination: Exposure of lettuce seeds to far-red light for 16 minutes inhibited germination, but irradiation with red light caused rapid germination.

Coloring: Apples kept in the dark remained green, but those exposed to fluorescent light, which contains a red component, became bright red.

Elongation: Three bean plants received eight hours of daylight each day. One which also received a 5-minute daily exposure to elongation-promoting far-red light just after the beginning of each dark period far outstripped the other two in growth. One of these received no artificial light, and the other 5 minutes of far-red followed by a 5-minute exposure to elongation-suppressing red light, which counteracted the effect of the far-red.

Flowering: Eight hours of daylight were received each day by three petunias. One which got eight additional hours of incandescent light (a mixture of red and far-red) flowered, while that which was given an additional 8 hours of fluorescent (red) light developed buds which flowered only after considerable delay. The plant

MORE AND BETTER FOOD, flowers, and fiber for industry are expected to result from experiments conducted by government scientists in one of the world's most brightly lighted plant growth rooms. Literally blanketing the ceiling, General Electric Power Groove fluorescent lamps, with 100-watt incandescent bulbs, provide more than 100 times as much light as exists in the average office. Here Dr. H. A. Borthwick, chief physiologist at the U.S. Department of Agriculture's Plant Industry Station, Beltsville, Md., inspects a plant after a test which showed faster growth in the new room than in less brightly lighted rooms or in nature.

which got only 8 hours of daylight showed the least development.

The period of time a plant is exposed to light has an important effect on its growth response. Lobolly pine trees, for example, grow six times as fast as normally when exposed to light 4 hours a day. On the other hand, only 0.0001 second of light causes lettuce seeds to germinate.

It is the duration of darkness rather than light that controls flowering, according to Dr. Borthwick. Some plants, such as poinsettia, hemp, millet, and chrysanthemum, need long daily dark periods for flowering. Short-night plants, such as wheat, barley, rye, beet, spinach, and certain summer-flowering weeds, can flower only when daily dark periods are short.

Ordinarily, the day-length of a region cannot be changed to fit the needs of a field crop. However, experiments in plant growth rooms have helped in the selection of the proper crop or crop variety to fit the region. For example, nine distinct groups of soybeans are used in this country, each adapted to a cross-country belt about 100 miles wide. The Biloxi variety thrives along the Gulf Coast, but does not do so well 300 miles farther north in Arkansas.

In breeding a new variety of plant, it must be carried through several generations. Because a plant growth room provides freedom from day-night and seasonal cycles, scientists are able to grow as many as six generations of some kinds of plants yearly, thus speeding up the development of special strains. This is in contrast to one generation in nature.

Best-known use of light to control flowering is that employed by the chrysanthemum industry. Chrysanthemums normally flower in the late summer, but their flowering often is delayed intentionally by growers who provide a few hours of light during the night. Similar techniques are used by growers of poinsettia plants, which respond to only a few minutes of light. **EE**

OLD, SLOW grease-pencil method of plotting aircraft seen in upper portion of photo contrasts sharply with new U. S. Navy display console in foreground. Developed by the Hughes Aircraft Company's ground systems group at Fullerton, Calif., the consoles display graphically all aspects of aerial, sea-surface, and submarine warfare for combatant ships within a fleet task force. Soon to be installed in ships of the U. S. Navy, NTDS will eliminate human error and delays which often plagued the old system and will provide lightning-fast battle intelligence at a central point aboard each ship where prompt counter-action may be initiated.

First Photos Released of Data Displays for Missile Ships

The U. S. Navy and Hughes Aircraft Company recently released the first photos of unique new battle data display consoles which provide for the first time a quick graphic picture of a fleet task force's entire tactical situation or any part of it as needed.

They will be installed in the Navy's most modern aircraft carriers and missile-armed ships as part of the Naval Tactical Data System (NTDS), the announcement said.

The display consoles, manufactured by Hughes' ground systems group, Fullerton, Calif., were said to "plainly show the positions of airborne, surface and submarine targets."

"The displays will make it possible for key command personnel of a vessel to comprehend the immediate tactical situation, enabling them to concentrate their judgment upon the jobs of controlling the ship, assigning the weapons and coordinating the fleet task force operations," C. H. Brubaker, Hughes vice-president, said.

Under a contract with the Bureau of Ships, Hughes developed an experimental data display group for installation at the Navy Electronics Laboratory at San Diego, Calif., where extensive tests demonstrated its system capabilities for the NTDS. The company is now building five service test shipboard display systems. **EE**

Motion-Picture Projector For Use in Commercial Aircraft

A remote-controlled 16mm sound motion-picture projector to be used in a commercial aircraft has been developed by the Reevesound Co., Inc., a subsidiary of Reeves Soundcraft Corp. (AMEX). The new motion-picture system was designed for Inflight Motion Pictures, Inc., to be used by major transcontinental and intercontinental airlines for airborne presentation of prerelease feature pictures. Each program is to run from 1½ to 2 hours.

The first prototype system was developed to operate in Boeing 707 Jets. The first installation has been made in an intercontinental 707 Jet operated by TWA. In order to meet the space and weight problems in the jet plane, Reevesound developed a transistorized sound system for motion-picture projection. The equipment is contained within the structure of the plane so that its presence will not be apparent to the passengers. When the flight hostess is ready for the film showing, she will make an announcement to the passengers over the public address system and will distribute small, lightweight headsets which each passenger will plug into a receptacle inconspicuously mounted on his seat. The flight engineer starts the movie which runs until completion and then shuts itself off automatically. Privacy is maintained because the sound is distributed individually by wire.

For the convenience and safety of passengers, Reevesound Co. has provided an electric interlock system which permits the captain and hostesses to address all passengers during the showing. Those who are not listening to the movie sound will hear the message over the standard public address system. Those who are listening to the movie will have the sound track interrupted and will hear the flight announcement through their headsets. **EE**

NBS Scientists "Listen" to Earth's "Pulse"

Using a sensitive antenna wrapped with miles of fine, hair-like copper wire, scientists at the National Bureau of Standards intend to "listen" to the earth's "pulse."

One hundred and thirty miles of thin, nylon-coated copper wire is being wound on a loop only 6 feet in diameter to make an antenna sensitive enough to respond to faint, low-frequency electromagnetic waves or micropulsations which exist on a world-wide basis. The signals which the loop antenna will receive below 20 cycles per second are principally oscillations of from 5- to 30-second periods. These micropulsations have been known to the scientific world since 1861, but little is understood about their origin or why the oscillations occur as they do. It is known that the signals are much stronger in the auroral zones and that they are probably associated with the influx of primary electrons into the ionosphere after the occurrence of solar storms.

Actually, eight of the sensitive loop antennas are in the process of being wound at NBS' Boulder Laboratory. One will be placed in the Boulder vicinity and another will be situated at Huancayo, Peru, to facilitate the study of micropulsations which is being made under the direction of Dr. W. H. Campbell of the Low Frequency and Very Low Frequency Research Section, Ionosphere Research and Propagation Division. The other six antennas will be used in the future to equip two portable stations where research will be conducted to measure and define the direction of micropulsations over broad areas.

The 130 miles of copper wire is wound on the rim of the loop in four separate channels. Then the copper wire is covered by a layer of copper screening, and finally the whole antenna is coated with Fiberglas to waterproof it. This is necessary since the antenna will be buried in the earth to prevent interference from wind action.

Although the antennas will be used primarily in the study of micropulsations, they will also be of value in the study of two other types of electromagnetic waves —extra low-frequency sferics, which originate from lightning discharges, and 1- to 3-minute giant pulsations which are thought to be caused by the resonation of the outer atmosphere when bombarded by charged particles from the sun.

Information gained through the use of these loop antennas will aid in the understanding of the complicated solar-terrestrial relationship. **EE**

New Electronic Imaging Tube To Study Space

A new electronic imaging tube, placed on a vehicle in space, will enable scientists to learn more about the stars and the depths of interstellar space. Developed by scientists at the Westinghouse Research Laboratories, the tube is sensitive to the short wave length ultraviolet light rays that are emitted by celestial bodies but never reach the surface of the earth since they are screened by the atmosphere.

Called the Uvicon, the new ultraviolet-sensitive tube was developed for the Astrophysical Observatory of the Smithsonian Institution, Cambridge, Mass., for the Observatory's Project Celescope.

A description of the tube and its application was given by A. E. Anderson, manager of the Westinghouse applied physics department, and Dr. R. J. Davis, Smithsonian astrophysicist in charge of Project Celescope.

A. E. Anderson, manager of the applied physics department of the Westinghouse research laboratories, installs in a television camera a new electronic imaging tube, the Uvicon. Operating on ultraviolet radiation that is normally screened by the atmosphere and never reaches the earth's surface, the new tube is the heart of an electronic telescope that will be fired into space, and eventually placed into orbit aboard a satellite observatory.

Project Celescope, Dr. Davis said, is one of several experiments planned to be launched in the National Aeronautics and Space Administration's (NASA) orbiting astronomical observatory program. NASA has announced that the first of the orbiting observatories is planned for 1963.

"NASA will launch a series of rockets from its Wallops Station, Va., site, employing the Aerobee-Hi rocket, to place the Uvicon and its associated electronic equipment well beyond the absorbing portion of the earth's atmosphere," Dr. Davis explained. "The purpose is to sample the strength and nature of the ultraviolet radiations we will encounter and to get preliminary data on the performance of the entire Project Celescope electronic telescope system."

Essentially, this telescope consists of three components: (1) an optical arrangement to form the ultraviolet images; (2) a Uvicon pick-up tube and its associated circuitry, which constitute a television camera that responds to the ultraviolet images and converts them into electric signals; and (3) a transmitter to broadcast these signals back down to earth. Thus, in television fashion, scientists hope to get a picture of the stars and interstellar space that always has been screened from man's vision.

The ultraviolet telescope package will go into the nose cone of an Aerobee-Hi rocket, which will take it to an altitude of about 150 miles. The useful portion of the flight will be the 5 minutes spent above an altitude of 60 miles, which is the height at which the ultraviolet radiations of interest cease to be absorbed. At this height the protective front portion of the nose cone will be jettisoned and the telescope exposed to the skies.

Information on brightness of stars will be telemetered to electronic storage equipment on the ground for final analysis of stellar magnitudes. In addition, the presence of sources of ultraviolet radiation in interstellar space will be recorded.

Mr. Anderson described the Uvicon as an extremely sensitive image tube operating in the range from 1,200 to 2,000 Angstroms. The tube is about 2 inches in diameter, 12 inches long, and weighs about 8 ounces.

In operation, the Uvicon receives an ultraviolet image through a special window, made of lithium fluoride, mounted at the input end of the tube. The back surface of the window is coated with a photo-emitting material that releases electrons when the ultraviolet image strikes it. These electrons are accelerated by 15,000 volts toward the rear end of the tube, where they strike a thin film or target.

The impact of the electrons on the target causes it to take on an amplified electric charge in the exact pattern of the ultraviolet image. The next step is to read off this charge as an electric signal and thus reproduce the image electrically. This is done by scanning the rear surface of the target with a beam of electrons, much as an electron beam scans the viewing end of a television picture tube. In the Uvicon, however, the product of the scanning is an electrical "image" that can be amplified and broadcast rather than a visual image that can be seen directly. The overall technique is known as electron bombardment induced conductivity. **EE**

Glass Piping For Shock Wave Tests

Head-on collision of two shock waves traveling 80 times faster than sound has been achieved in a hydromagnetic tube made of glass.

Boeing Airplane Company scientists developed this unusual use for glass piping in a study of high-temperature gases. The tests are being conducted at the Boeing Scientific Research Laboratories, Seattle, Wash.

The glass tube, manufactured by Corning Glass Works, is 12 feet long and 6 inches in diameter. Boeing scientists believe it is the largest tube ever used in an experiment of this kind.

Because the tube is transparent, still photographs can be taken of the colliding shock waves. At impact, the Pyrex piping is brightly illuminated.

The naked eye catches only a brief flash, but the camera with shutter left open in a darkened room records the collision. The flash is accompanied by a loud report similar to an exploding firecracker.

The experiment is part of a study of high-temperature gases being made by Dr. T. E. Turner, Dr. Joe Gauger and Dr. Victor Vali, members of the gas physics group in the Boeing Laboratories.

Boeing explained that studies growing out of the shock tube program could have important results in the development of effective ion and plasma-propulsion systems. The tube, built by Boeing Scientific Research Laboratories scientists and technicians, is expected to be useful in measuring temperatures of gases up to several million degrees. It also will be used in the study of microwave emission and energy loss through radiation.

The shock waves are driven through the

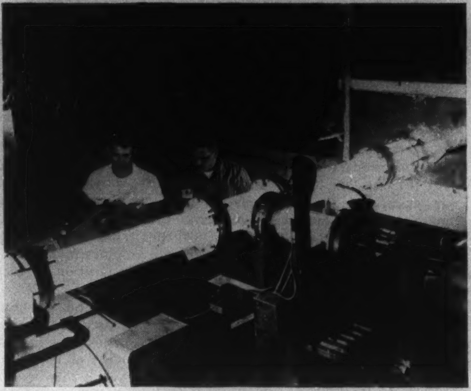
glass piping by a surge of electric power equal to the output of four Grand Coulee Dams. The electric energy used to create the waves is stored in two 20-capacitor banks rated at 20,000 volts with a combined peak power of between 2.5 and 5 million kw.

Once triggered, the shocks last only a few microseconds, but create a gas temperature within the tube of approximately 1 million degrees.

Boeing said the thermal as well as the magnetic energy in the electric discharge creates shock waves which initially race along at 300 times the speed of sound. After traveling about 60 inches toward the center of the tube, however, both shock waves are "slowed" to about 80 times the speed of sound—still more than two dozen times the speed of a rifle bullet.

Through the glass, the velocity of the shock waves and spectra of radiation from the gas are recorded with a high-speed rotating mirror camera. Boeing also is using a new vacuum ultraviolet grating spectrograph—a device for separating light into its components—to evaluate the data.

The glass piping used in these experiments is made by Corning from the same borosilicate glass used for chemical and food processing lines, drainlines, and heat exchangers. **EE**



SECTION of Pyrex Brand glass piping, manufactured by Corning Glass Works, is being used as industry's most powerful shock tube. Built by Boeing scientists, the tube creates shock waves which begin at 300 times the speed of sound and then collide in the tube at a "slowed" rate of 80 times the speed of sound. Tube is used to help develop effective ion and plasma-propulsion systems for use in space.

South Atlantic Wood Pole Conference

The Wood Products Department of the North Carolina School of Forestry will sponsor the South Atlantic Wood Pole Conference at Raleigh, N.C., April 5-6. The conference will be held in the Student Union on the campus of the North Carolina State College.

A comprehensive program of basic technology and current information on the production, deterioration, preservative treatment, purchasing, inspection, and maintenance of wood utility poles will be presented.

The conference is open to all interested persons. Those wishing to attend may obtain copies of the conference program and advance registration by writing to the Wood Products Extension Section, 266 Kilgore Hall, North Carolina State College, Raleigh, N.C. **EE**

Experimental Drilling to Test Equipment for Project Mohole

Plans have been completed for an experimental deep-sea drilling program beginning in March to test equipment and techniques for possible use in Project Mohole, it was announced recently by the National Science Foundation (NSF) and the National Academy of Sciences–National Research Council.

The ultimate goal of Project Mohole is to drill through the earth's crust under the ocean to determine the composition and physical properties of the crust and of the underlying rock known as the mantle.

A test site for the experimental drilling has been chosen near Guadalupe Island, off the western coast of Mexico, in 12,000 feet (about 2.3 miles) of water. Previous drilling has been confined to water depths of several hundred feet.

A contract for the test drilling has been awarded Global Marine Exploration Co., of Los Angeles, Calif., by the NSF, an independent agency of the Federal Government. The program is under the technical direction and scientific guidance of the AMSOC Committee of the Academy-Research Council, a private organization of scientists and engineers.

The experimental drilling program was announced jointly by Dr. A. T. Waterman, director of the NSF and Dr. D. W. Bronk, president of the Academy-Research Council.

Actual drilling of the Mohole depends upon the outcome of the experimental drilling, subsequent engineering and design studies, and site surveys, and is not expected to begin for several years.

Nearly all previous offshore drilling has been in water less than 100 feet deep, with the drilling platform standing on the ocean bottom. An anchored vessel has worked in water 400 feet deep and has drilled as far as 10,000 feet.

In the current tests, drilling will be attempted with the unmoored ship holding its position by means of four large outboard motors, in water roughly 30 times deeper than the 400-foot depth.

The actual Mohole must be drilled at sea through the thinner suboceanic crust because the crust under continents is too thick to be penetrated. The boundary between the crust and the denser material of the mantle is known as the Mohorovicic discontinuity (or Moho, for short), after the Yugoslav seismologist whose studies of earthquake waves first indicated its existence.

Beneath the continents, the crust of the earth has a thickness of about 15 to 20 miles, being thickest under mountains, while the suboceanic crust may be as thin as 2.5 miles in some places. The eventual Mohole may be drilled in water as much as 18,000 feet deep (3.4 miles) into a thickness of about 15,000 feet of crustal rock, a total of about 32,000 feet (6 miles). The deepest hole drilled from land is just over 25,000 feet (4.7 miles) in depth.

The mantle extends down to a depth of about 3,000 miles and accounts for about 84% of the volume of the earth. Although volcanoes in oceanic areas erupt lava that probably originates in the mantle, lava is thought not to be characteristic of average mantle material. The material below the mantle is called the core, and may be nickel-iron.

Drilling will be done by the standard rotary method used on land by the petroleum industry. A main objective of the drilling will be to confirm by actual test the elaborate engineering computations of the forces and stresses acting on the ship and the drill pipe, the determination of optimum drill pipe rotation speed, and the necessary amount of weight on the bit. All holes will be uncased—that is, the only connection between the ship and the sea floor will be the drill pipe itself. This means that once a bit has been withdrawn from the hole, the hole cannot be re-entered. Therefore, all sampling and measuring operations must be conducted by lowering tools and instruments through the drill pipe on a cable, or wire line. Diamond bits will be used in all holes because both very soft and very hard rocks will be encountered.

Depending upon the success of the drilling and the depths which may be obtained, experiments will be conducted to record the physical properties of the sediments that have been penetrated. Data will be sought on electrical and heat conductivity; seismic velocity, or the speed at which the material will conduct seismic waves; and magnetic and gravity observations.

If such measurements can be obtained, they will have great scientific value in enabling scientists to compare the data with that obtained previously by indirect means.

Feasibility studies conducted by the AMSOC Committee with NSF support have indicated that the ship will be able to maintain position with the use of four diesel steering motors mounted at the corners of the ship. The ship's position will be determined relative to a ring of four or five buoys anchored to the bottom and held several hundred feet below the surface by taut lines. The design of the buoys is expected to minimize the offset caused by ocean currents.

The buoys will be equipped with sonar transponders, or "pingers," which respond to sound waves sent through the water by the ship in the middle of the circle. Electronic equipment on the ship will translate the signals received into distance, and present this to the pilot so that he can maintain position in relation to the buoys. The pilot will regulate the amount and direction of thrust of the steering motors through a central control to maintain the ship's position over the hole. **EE**

Computer-Designed Computer Announced

The first computer built from complete wiring information and parts lists furnished by another computer has been shipped to Ascension Island, near the target area of the Atlantic Missile Range. The computer is to be used in connection with target tracking tests for Nike-Zeus, the U. S. Army's antimissile defense system.

Bell Telephone Laboratories engineers revealed recently that the entire logic network of the digital computer, consisting of 47 subassemblies, had been built from wiring diagrams, assembly information, and parts lists produced by a specially programmed, general-purpose digital computer. The Nike-Zeus computer was built by the Western Electric Company, Burlington, N. C., prime contractor for the Nike-Zeus system.

The Bell Laboratories Automatic DEsign System, abbreviated BLADES, required less than 25 minutes per subassembly to produce manufacturing information which would have consumed 4 man-weeks of manual effort with conventional drafting methods. Use of the BLADE System can save thousands of man-weeks of time in the design of missile defense equipment and large sums in defense funds.

In addition, manufacturing information can be converted into a control program for an automatic wiring machine, which would do the actual assembly work. Initial experiments on this aspect of the program are now underway, and results indicate that automatic wiring of the mechanically designed computer is feasible. This will, of course, result in additional substantial savings in time and money.

The first step in designing the computer was the synthesis of the logic network to the necessary functions. This network was then converted into a set of topologic equations, expressing both the topology and logic of the network, in computer language. (Topology involves the geometric aspects of the network; i.e., the position of each component and its relation to other components.)

The general-purpose computer then used these topologic equations to produce sheets of instructions specifying the number of modular logic packages to be used in a subassembly.

The instructions also specified the pins to be interconnected, the size and length of wire to be used in connecting them, and the wire paths to be followed for minimum path length. Any special-purpose logic packages to be used in a subassembly were also specified by the computer.

After the wiring information sheets were completed, a complete parts list including logic packages, externally wired resistors and capacitors, and necessary wire was prepared.

The majority of the logic packages in the Zeus computer are of a single general-purpose type. Any logic function can be performed anywhere on the subassembly by varying the interconnections among the packages. The module package contains four individual and independent logic switches which can be interconnected to form 2-, 3-, or 4-terminal logic gates, or flip-flop circuits.

The computer being shipped uses about 2,500 of these logic packages, plus about 200 packages of other types in its 47 subassemblies. The BLADE System, as currently designed, can handle up to 12 different types of packages.

Separate wiring instructions for power and signal wiring are provided. Also, power wiring is arranged so that no two successive logic functions are supplied by the same power bus. **EE**

ASSEMBLED for testing and check-out prior to being shipped to Ascension Island are some of the racks of equipment that make up the target track computer for the Army's Nike-Zeus antimissile defense system. The computer—the first made from complete information furnished by another computer—was built by Western Electric. Design and development was done at Bell Telephone Laboratories.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

THE ANTENNA. By L. Thourel. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1960. 407 pages, 6¼ by 9½ inches, bound. $12.50. Based on a course given at the École Nationale de l'Aviation Civile, near Paris, this authorized translation is essentially a manual for use in planning an antenna system to specific requirements. In effect a review of world-wide modern antenna techniques, it avoids complicated mathematical arguments, though indicating clearly and concisely the calculations from which the practical formulas given were derived. The first two chapters discuss antenna theory and the optics of electromagnetic waves. In the remaining chapters numerous types of antennas are described, with extensive study of antennas for decimetric and centimetric waves, and short-wave antennas, particularly rhombics, and examination of related concepts such as beamed transmission, radiation of apertures, electromagnetic horns, paraboloids, slot aerials, electromagnetic lens, transmission lines, and the circle diagram.

BIBLIOGRAPHY AND ABSTRACTS ON ELECTRICAL CONTACTS, 1959 SUPPLEMENT. Published as ASTM Special Technical Publication No. 56-N by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1960. 63 pages, 6 by 9 inches, paper. $3.50. This is the seventh annual supplement to a bibliography which now covers published material on the subject from 1835 through 1959 (STP's 56-G to 56-N inclusive). All include subject and author indexes, and annotated, fully cited items arranged chronologically by date of publication. The effects which take place in the operation of electric contacts are very complicated, involving the microphysics of the electric arc, the metallurgy of the contact materials, the mechanics of the operating mechanisms, the physical and chemical properties of all materials, and the ambient conditions. Limitation of ranges of titles and subject matter is a practical necessity, but all references of reasonable connection with the subject have been included.

DIGITAL APPLICATIONS OF MAGNETIC DEVICES. Edited by A. J. Meyerhoff. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1960. 604 pages, 6 by 9¼ inches, bound. $14. Both a text and a reference handbook, this book describes the theory, electrical design, and logical design necessary for the development of digital systems using the magnetic core as the basic circuit element. Attention is concentrated on core-diode circuits, but transistor-magnetic core combinations and other specialized data-handling circuits also are discussed. Specifically excluded are memories employing magnetic tapes and drums, other electromechanical devices involving magnetic phenomena, and standard magnetic amplifiers.

ELECTRONIC CIRCUIT ANALYSIS, VOLUME I: PASSIVE NETWORKS. By Phillip Cutler. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 454 pages, 6 by 9¼ inches, bound. $8. Written in lecture style with extensive detail and solved and unsolved problems in order to be self-teaching, this book is especially tailored to intermediate-level training in colleges and industrial training programs to bridge the gap between the engineer and the technician. The discussion covers passive networks from the standpoint of network analysis and theorems, a-c fundamentals and circuit analysis, transient analysis, the analysis of inductively coupled circuits and investigation of transformer equivalent circuits, and graphic analysis as applicable to nonlinear elements such as vacuum tubes and transistors. Future volumes will consider active networks in detail, and expand upon the analysis of passive networks.

ELEMENTS OF MASER THEORY. By A. A Vuylsteke. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1960. 362 pages, 6¼ by 9¼ inches, bound. $9.50. This is a basic guide to fundamental maser theory. Part one contains a brief description of the Bohr quantum theory and of statistical mechanics, forming a relatively complete though superficial survey of the basic phenomena responsible for maser behavior. Part two (chapters 2 to 4) presents as much of the theory of quantum mechanics, statistical mechanics, and radiation theory as the author feels necessary for the understanding of the last section of the book, which is concerned directly with masers. In Part three (chapters 5 to 8) is found a theoretical treatment of the most basic and currently well understood features of masers, omitting discussion of research in progress and such developments as optical and infrared masers.

FORTSCHRITTE DER HOCHFREQUENZTECHNIK. Edited by J. Zenneck and others. Akademische Verlagsgesellschaft m.b.H., Frankfurt am Main, West Germany, 1960. 321 pages 6½ by 9½ inches, bound. No price given. A group of eight articles review recent developments in various areas of high-frequency technology: scatter propagation, high-frequency transistors, fabrication techniques for high-frequency transistors, noise in semiconductors, fluctuation phenomena in the electron beam, delay lines for traveling-wave tubes and linear accelerators, properties of getters in electronic tubes, and a 2-year review of low- and very low-frequency propagation. Five articles are in English, three in German, with both English and German summaries and reference lists of English and German articles.

TOP MANAGEMENT HANDBOOK. Edited by H. B. Maynard. McGraw-Hill Book Company, Inc., 30 W. 42nd St., New York 36, N. Y., 1236 pages, 6¼ by 9¼ inches, bound. $17.50. This comprehensive collection of chapters written by top managers, carefully selected to represent a cross-section of type and size of industry and plant, presents authoritative discussions of each facet of the task of managing, written from the standpoint of personal experience. The nature of the task is emphasized, and such elements as gathering information, managing the research and development activity, managing the market activity, and building and retaining top management, are covered. The book includes short biographical sketches of the authors, and will be of interest to managers, management students, and to those interested in the thoughts and activities of the leaders of industry.

PRINCIPLES OF FEEDBACK CONTROL. By C. H. Wilts. Addison-Wesley Publishing Company, Inc., Reading, Mass., 271 pages, 6¼ by 9½ inches, bound. $8.75. This treatment of some of the analytical methods used in the design of feedback systems, requiring a good background in ordinary differential equations and complex variable theory. Described by the author as "not suitable as a reference handbook," it is a study of the principles of feedback control. Feedback systems are considered in the light of response and error functions, stability, compensation techniques and the concepts of root-locus and the Nyquist criterion. Multiple-loop, closed-loop, and sampled-data control systems are given particular attention. The final chapter examines the use of the describing function in nonlinear analysis.

THE RESEARCH REVOLUTION. By L. S. Silk. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, 1960. 244 pages, 5½ by 8¼ inches, bound. $4.95. In his examination of the growth potential and performance of the American economy, Mr. Silk views industry's growing realization of the importance of regular, systematic investment in scientific research and development as a new element in capital's growth process. This is the "research revolution." The author feels that continuous prosperity and healthy growth of the American economy increasingly depend on such investment, and illustrates how the "revolution" has worked in a major industry in the electronics field. An economist writing for wide distribution, Mr. Silk has condensed his material and avoided specialized terminology to the extent that the book may seem to some to be only a summary of the extensive information obviously at the author's command.

Library Services

ENGINEERING Societies Library books, except bibliographies, handbooks, and other reference publications, may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 W. 39 St., New York 18, N. Y.

THYRATRONS. By C. M. Swenne. The Macmillan Company, 60 Fifth Ave., New York, N. Y., 1960. 73 pages, 6 by 8½ inches, bound. $3. This is an introduction to industrial applications of thyratrons for the engineer. It covers briefly physical principles, electrical characteristics, basic circuits, and applications, avoiding elaborate physical and mathematical treatment in all cases.

PRACTICAL ELECTRICAL WIRING. By H. P. Richter. Sixth edition. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 585 pages, 5½ by 8½ inches, bound. $7.95. Conforming to the methods of the National Electrical Code, this book explains the "how" and the "why" in the wiring of structures of limited size and at ordinary voltages, under 600 volts. Part one presents the fundamentals of electrical work—terminology, basic principles, and the theory behind general practices. Part two deals with the actual wiring of residential buildings and farms. Part three covers the actual wiring of nonresidential buildings such as stores, factories, and schools. Only essential basic engineering data are included, since this is not a book on electrical engineering. Revisions in this edition have been made to clarify presentation of principles, and to modify methods in accordance with developments in materials and techniques.

SYMPOSIUM ON NONDESTRUCTIVE TESTING IN THE MISSILE INDUSTRY. Published as ASTM Special Technical Publication no. 278 by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1960. 71 pages, 6¼ by 9¼ inches, bound. $2. This volume contains seven of the eight papers presented at the Symposium, held in San Francisco, Calif., on October 12, 1959. Included are papers on radiography of rocket motors, of weldments in motion, and in the 6- to 30-mev range; ultrasonics in sandwich structures inspection, fluid-contaminating particle detection, and evaluation of missile materials and components; and mobile field inspection of missiles and aircraft.

TELEPRINTER SWITCHING. By E. A. Rossberg and H. E. Korta. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1960. 351 pages, 6½ by 9½ inches, bound. $10.75. This translation from the German original presents a survey of the teleprinter switching systems in service all over the world. It avoids fundamentals, discussing instead the peculiarities and salient features of the various systems. Two chapters describe the two principal systems—direct subscriber-to-subscriber, and message relay from one section of the circuit to the next—in German, Swedish, Finnish, Danish, French, British, and American installations. The remaining chapters deal with such topics as rate metering, maintenance equipment and facilities, planning criteria, and traffic analysis.

THERMOELECTRIC MATERIALS AND DEVICES. Edited by I. B. Cadoff and Edward Miller. Reinhold Publishing Corporation, 430 Park Ave., New York 22, N. Y., 1960. 344 pages, 6¼ by 9½ inches, bound. $9.75. From the College of Engineering of New York University comes this treatment of the technology and engineering applications of thermoelectric materials. It describes the theory of thermoelectric processes and the thermoelectric circuit, evaluates theoretical and experimental materials for use as thermoelements and discusses materials now in use as well as those being considered for future use, reviews the principles of device design, and describes some experimental and prototype units which have been built and evaluated.

1301 REVIEW PROBLEMS. By R. C. Brinker and others. International Textbook Company, Scranton, Pa., 1960. 338 pages, 6¼ by 9¼ inches, bound. No price given. The purpose of this book is to provide an intensive practical review for persons planning to take the Professional Engineer's registration examination and the prerequisite EIT (Engineer-in-Training) exam which follows graduation and generally precedes practical experience. Individual problems selected from actual state registration exams form the basis of the review, and are arranged in two sections, corresponding to the two parts of the EIT exams. The "General" section (Chapters 1 to 11) covers such subjects as mathematics, chemistry, statics, thermodynamics, fluid mechanics, electricity, engineering economy, ethics, and contracts. The "Applied Engineering" section (Chapters 12 to 19) covers aeronautical, chemical, civil, mechanical, electrical, industrial and mining engineering, and surveying. The remainder of the book (Chapter 20), contains nine complete typical state examinations. Appendixes give answers, symbols and abbreviations, addresses of state registration boards, and recommended reference books.

SYMPOSIUM ON SPECTROSCOPIC EXCITATION. Published as ASTM Special Technical Publication No. 259 by the American Society for Testing Materials, 1916 Race St., Philadelphia, Pa., 1960. 62 pages, 6 by 9 inches, paper. $2.50. At the 62nd Annual Meeting of ASTM in Atlantic City, June 1959, this symposium considered some of the parameters involved in obtained reproducibility and accuracy in spectroscopy. The three papers included here discuss the matrix effect in excitation, the effects of gaseous atmospheres on excitation, and some properties of excitation sources such as flames and electric discharges, including hydrocarbon flames, plasma jets, and high-frequency, interrupted, continuous, and fluid-controlled arcs.

TECHNICAL WRITING. By Joseph Racker. Prentice-Hall, Inc., Englewood Cliffs, N.J., 1960. 234 pages, 6¼ by 9¼ inches, bound. $6.95. A handbook written by an engineer with a long and varied experience in technical writing, this book sets forth rules, formulas, techniques and ideas in technical writing which will help the engineer select those elements of his material which he wishes to communicate, and to organize and present them in a manner which will reach his readers at the level of their understanding. The author first defines "technical writing," and "writing level," and then gives examples of the five levels he sets up—from the operator's or nontechnical level, to the advanced engineering or scientific level of reader understanding. Then the selection of the appropriate words, and letter and mathematical symbols is discussed, followed by description of illustrations, and the preparation of manuscripts. The book is completed by five glossaries of terms used in writing about such special topics as computers, automation, electricity, electronics, guided missiles, radio and radar navigation, space technology, and transistors.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

EDUCATIONAL TV GUIDEBOOK. Representing the most complete work available on television as an instruction tool, the book presents nearly 100 illustrations in a sequence designed to develop a basic understanding of the components and workable combinations of television facilities to meet varying educational applications. It deals with such innovations in electronic instruction as translators, video tape, the Midwest Program on Airborne Instructional Television, the Galveston experiments with Phonoscope, low-power educational television provisions, and closed-circuit library reference system. Included are an extensive glossary, case studies, and checklists for determining guidelines to educators in introducing instructional television. Financed by Electronic Industries Association (EIA), the book was written by Dr. Philip Lewis, director of the Bureau of Instructional Materials of the Chicago Board of Education. It is available from McGraw-Hill Book Co., 30 W. 42nd St., New York 36, N.Y., at $4.95 per copy.

DATA PROCESSING ANNUAL. *Reference Guide, Volume Two.* This volume for users of punched card, punched tape equipment and business computers contains valuable educational information. The "Computer Guide" feature introduced in Volume One has been updated by displaying all commonly used types of current electronic computers, with basic descriptions and characteristics. A computer comparison chart gives the specifications of each type at a glance. It includes a bibliographical index of information on articles which have appeared in more than a hundred different periodicals, indexed by subject and author. It is available from Gille Associates, Inc., 22nd Floor Book Tower, Detroit 26, Mich. for $15 per copy.

RESEARCH HIGHLIGHTS. This 1960 Annual Report of the National Bureau of Standards presents a general review followed by highlights of the research program on metrology, electricity, radio standards, mechanics, heat, atomic physics, radiation physics, chemistry, mineral products, organic and fibrous materials, metallurgy, instrumentation, applied mathematics, building research, data-processing systems, cryogenic engineering, radio propagation, weights and measures. It is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 65¢ per copy.

HANDBOOK OF TEST METHODS AND PRACTICES. Written to meet the electronics technician's need for a convenient reference on the fundamentals of testing electronic equipment, this manual discusses the importance of testing; provides the technician with a sound background in test equipment circuits theory; covers in detail the specific procedures used in testing communications, radar, and sonar; and deals with preventive maintenance and repair of test equipment. Priced at $2.75 per copy, it is available from the U. S. Government Printing Office, Division of Public Documents, Washington 25, D. C.

THEORY AND USE OF ELECTRONIC TEST EQUIPMENT. This Army technical manual describes the theory and use of nearly every important radio test instrument, such as multimeters, vacuum-tube voltmeters, signal racers, tube checkers, and other devices used to locate electronic trouble. Available from the U. S. Government Printing Office, Division of Public Documents, Washington 25, D. C.; price 75¢.

ENCYCLOPAEDIA OF DRAWING AND DESIGN. *Mechanical, Electronic, Architectural & Art.* This volume, consisting of numerous loose-leaf hole-punched simplified pages of text and clarified drawings, illustrations, paintings, and photographs, should prove useful to students, teachers, draftsmen, technicians, and engineers. It deals with mechanical and electronics drawing, architectural and structural drawing, commercial and fine art drawings and paintings, machine design, metallurgy, electronics theory, mathematics, drafting room short cuts and essentials, design theory, reproduction methods, etc. It may be obtained from Louis D. Prior, Inc., 23-09 169th St., Whitestone 57, New York, N.Y., for $9 plus 27¢ sales tax.

AMERICAN STANDARD ACOUSTICAL TERMINOLOGY *(Including Mechanical Shock and Vibration), SL. 1-1960.* This is a comprehensive revision of American Standard Z24.1-1951, and is the result of 6 years of work by representatives of 26 national groups which participate in three ASA sectional committees. The 62-page standard includes 5 tables and 15 sections with over 600 definitions on such diverse subjects as transducer parameters, underwater sound and sonics, architectural acoustics, music and acoustical units. The standard is available from the American Standards Association, 10 E. 40th St., New York 16, N.Y. at $4.50 per copy.

RADAR CIRCUIT ANALYSIS. Presenting the basic principles and basic circuits of radar, this U. S. Air Force manual includes chapters on a-c and d-c circuits, measuring instruments, vacuum tubes and power supplies, principles of radar, timing circuits, amplifiers and oscillators, modulation and detection, r-f lines, waveguides and cavity resonators, oscillators at radar frequencies, radar antennas, and selsyns and servomechanisms. It is designed to provide the graduate radar technician with reference information on fundamentals of electronics and the student radar technician with a basic coverage of the subject. Available from the U. S. Government Printing Office, Division of Public Documents, Washington 25, D. C., for $3.25 per copy.

MATHEMATICAL MACHINES: *Volumes I and II.* Prepared under the auspices of the Office of Naval Research by F. J. Murray, professor of mathematics at Duke University and director of special research in numerical analysis, this work fully recognizes the vital contribution of mathematical machines to investigations in science and technology. The volumes follow the practical division of digital and continuous machines. The first deals with devices based on digital representation numbers discussing the principles of desk calculators, punched-card machines, and automatic sequence calculators. The second volume covers continuous computors, analogs, and mathematical instruments. Illustrated, with charts and tables, priced at $15 per volume, these books may be ordered from the Columbia University Press, 2960 Broadway, New York 27, N.Y.

ENVIRONMENTAL EFFECTS ON MATERIALS AND EQUIPMENT. This new monthly abstracts journal is intended to aid design engineers, materials scientists, specification writers and evaluators, test personnel, research directors, and others who are charged with responsibility of guaranteeing the reliability, operability, and durability of military and other materiel in all environmental conditions of transportation, storage, and use. The field emphasized in this publication is that variously referred to as the "induced," "hyper," or "space-associated" environment and includes effects of such factors, or combination of factors, as shock, vibration, excessive heat, vacuum, gravity, magnetism, electromagnetic radiation, dissociated and ionized gases, meteoritic dust, auroras and coronas. Each issue will contain 40 substantive abstracts plus 40 "extracts"—telegraphic or key-word abstracts—of current articles drawn from world scientific literature. Subscription to the journal, which commenced publication January 1961, are $25 per year from National Academy of Sciences, 2101 Constitution Ave., Washington 25, D. C.

NUCLEAR FUSION, *Journal of Plasma Physics and Thermonuclear Fusion.* This quarterly international journal contains reports of original work and review articles concerning plasma physics and controlled thermonuclear fusion research. Letters to the editor and shorter communications, as well as bibliographic material are also included. Orders for subscriptions should be sent to the International Atomic Agency, Kaertnerring 11, Vienna I, Austria. Annual subscription rate is $10.

RUSSIAN ENGINEERING JOURNAL. Translated by Production Engineering Research Association of Great Britain, this second cover-to-cover translation of a leading Russian technical journal will prove of assistance to those in industry concerned with design and production and also to librarians as an up-to-date reference aid when dealing with enquiries concerning latest Russian engineering developments. Among subjects covered are structural design, materials, production, power plant, power transmission, plant and machinery, and finishing. It may be ordered from Production Engineering Research Association, Melton Mowbray, Leicestershire, England. Subscription rates: for United States and Canada, $27 per annum; for libraries of educational institutions, $20.

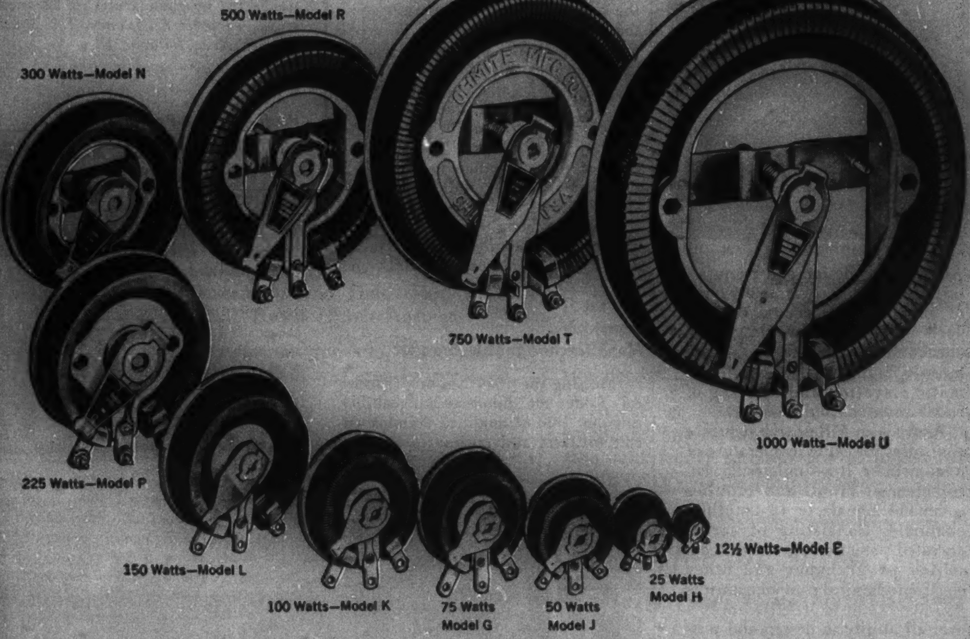
DIGEST OF MILITARY ELECTRONICS. Written in simple language and explaining terminology often heard, but usually difficult to understand, this 210-page book gives the layman and the technical man alike a general speaking acquaintance with the many ways in which modern electronic systems serve the U. S. Armed Forces. The practice of giving special names and short titles to electronic equipment and systems is widespread in both Government activities and civilian fields. RADAR, LORAN, SONAR, ILS, BMEWS are but a few examples. Through usage these terms often acquire definitive meanings and obtain the status of words in official and unofficial spoken and written language. The book presents these special names in alphabetical order, and explains briefly the purpose and function of each from a system standpoint. It is available for $3.95 from RCA Service Company, Government Services, Bldg. 210, Camden 8, N.J.

HANDBOOK OF NOISE MEASUREMENT. This illustrated 100-page handbook covers the measurement of noise and vibration, and describes equipment requirements, procedures, and the interpretation of results. In 13 chapters it offers a comprehensive survey of such topics as the decibel, man as a noise-measuring instrument, applications of sound-measurement system, and the measurement of sound levels and sound-pressure levels. Also detailed are the characteristics of noise control, loudness levels, speech interference, hearing damage, and neighborhood reaction to noise. In addition, typical noise sources are discussed, and vibration measurements are the subject of reports on typical instrumentation and applications. Four appendixes include decibel conversion tables, vibration charts, definitions, and extensive references. Copies are available at $1 each from General Radio Company, West Concord, Mass.

IEC PUBLICATIONS. The International Electrotechnical Commission (IEC) has published the following: *IEC Publication 71: Recommendations for Insulation Coordination* which sets forth the conditions to be fulfilled by the insulation of electric equipment—except generators, rotating machinery, underground cables, and overhead lines—used in exposed installations on a-c systems having a nominal voltage greater than 1 kv. Price $3.20. *IEC Publication 119: Recommendations for Polycrystalline Semiconductor Rectifier Stacks and Equipments* applies to selenium and copper-oxide stacks, rectifiers and rectifier equipment used for supplying d-c power from a-c sources at frequencies up to 2,000 cycles. It does not cover telecommunication rectifiers other than those for power supplies to such apparatus, nor rectifiers used as auxiliaries of measuring instruments. The recommendations which define the characteristics of these devices, provide a marking system, given preferred ratings and described methods of test. They are divided into three main sections: general, semiconductor stacks, and rectifier equipment in general. Price $8. *IEC Publication 120: Recommendations for Ball and Socket Couplings of String Insulation Units* specifies a series of four standard sizes of ball and socket couplings for use in assembling string insulator units into chains. An appendix gives the dimensions of a series of gauges for checking the couplings. Price $8. *IEC Publication 51: Recommendations for Indicating Electrical Measuring Instruments and Their Accessories* applies to the following types of indicating electric measuring apparatus for direct and alternating currents: ammeters, voltmeters, single-phase and poly-phase wattmeters, varmeters and phasemeters, frequency meters of the pointer and vibrating reed types and ohmmeters. It deals with certain accessories used with these instruments, such as shunts, series of resistors, inductors, and capacitors. Instruments incorporating rectifiers, diodes and thermocouples are covered, but electronic measuring instruments, including transistorized instruments, are excluded. Price $6. All of these publications are available from the American Standards Association, Dept. 197, 10 E. 40th St., New York 16, N.Y.

World's Largest Selection

SIZES • VALUES • STOCK UNITS • SPECIAL FEATURES


500 Watts—Model R
300 Watts—Model N
750 Watts—Model T
1000 Watts—Model U
225 Watts—Model P
150 Watts—Model L
100 Watts—Model K
75 Watts Model G
50 Watts Model J
25 Watts Model H
12½ Watts—Model E

OHMITE offers the largest and most varied assortment of power rheostats ever developed.

You can choose from 413 *stock* commercial sizes and types ranging from 12½ to 1000 watts . . . or from over 400 *stock* MIL-R-22A sizes and values, with "special fast delivery" on *all* other MIL units. You can find, for example, scores of different shaft styles, sizes, configurations—already engineered and waiting. Literally, hundreds of other special features take care of any rheostat application envisioned today.

But Ohmite rheostats give you more than just "largest selection." Ohmite wire-wound units of *all ceramic and metal construction* represent the highest degree of operational reliability ever attained in rheostats. They bring you the backup of industry's greatest reservoir of engineering talent in rheostat design and application.

Because of this, you find more Ohmite units in use than all other makes combined. On your next project calling for rheostats, make your selection from the smooth, close control units preferred throughout industry.

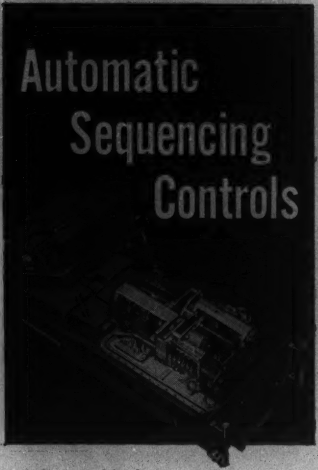
Stocked by the Factory and Electronic Distributors Everywhere

OHMITE RHEOSTATS

OHMITE MANUFACTURING COMPANY
3614 Howard Street, Skokie, Illinois

OHMITE

- Rheostats
- Power Resistors
- Precision Resistors
- Variable Transformers
- Tantalum Capacitors
- Tap Switches
- Relays
- R.F. Chokes
- Germanium Diodes
- Micromodules



AiResearch's design and manufacturing capability covers many types of automatic sequencing controls such as those for missile ground checkout, controlling drone and missile flight profiles, and automatic elevation and leveling of radar antennas and missiles.

Above is an AiResearch sequence controller for cabin temperature of a jet airliner. It assimilates 25 sensor element inputs and supplies command signals to 18 amplifier channels. Consisting of servo-operated potentiometer cards, cam switch programmer and other electromechanical components, it is another example of AiResearch's over-all ability to design and produce intricate and complicated servo systems.

The most experienced company in the development and production of control systems for airborne and ground use, AiResearch is an industry leader in electromechanical systems and components of all types for aircraft, ground handling, ordnance and missile systems.

OTHER ELECTROMECHANICAL COMPONENTS AND SYSTEMS

AC and DC Motors, Generators and Controls • Static Inverters and Converters • Linear and Rotary Actuators • Power Servos • Hoists • Temperature and Positioning Controls • Sensors • Programmers • Missile Launchers • Radar Positioners • Power Supplies • Williamsgrip Connectors

Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

New & Improved Products
(Continued from page 8A)

Vacuum Control Switch . . .

In conventional vacuum-actuated control switches, the contacts are usually exposed to the vacuum system oils which often act as insulators across the contacts when pressure rises above the desired level. Contact failure is eliminated with this latest control switch by enclosing four separate fixed-control contacts and a common return contact inside an ordinary U-tube manometer partially filled with mercury. At no time are these contacts exposed to the vacuum system. When the pressure falls, indicating better vacuum, the mercury column on the closed manometer leg falls, exposing the contacts and presenting a control action. *The Fredericks Co., Bethayres, Pa.*

Noninterchangeable Breaker . . .

Meeting the 1959 National Electrical Code for noninterchangeability, this new line of modified Stab-lok circuit breakers and enclosures prevents substitution of breakers above 20 amperes capacity without a special tool available only to qualified electrical wiremen. Steel clips fastened to the back of the breaker unit and embossed in the rear of the enclosure with intact knock-outs prevent higher capacity Stab-loks from being inserted. The 15- or 20-ampere breakers, however, do not have these clips and are therefore not impeded by the rear of the enclosure panel. *Federal Pacific Electric Co., 50 Paris St., Newark 1, N.J.*

High-Vacuum Tuning Fork . . .

Providing an extremely accurate frequency source for precise electronic instruments, type *TF-4* with silicon transistor oscillator operates on any frequency from 240 to 10,000 cps. Accuracies are 0.005% or better from —56 to —125 C. Ovens or other complex thermal controls are unnecessary. The output signal is either a sine or square wave of 1.3 to 3.0 volts rms across a 10,000-ohm load from a supply of 6 to 36 volts d-c with a current drain of less than 10 ma. The device is unaffected by gamma rays or fast neutrons. *Time & Frequency, 127 South Batavia Ave., Batavia, Ill.*

High-Voltage Power Supply . . .

Up to 350,000 volts d-c with continuous current of 8 milliamperes and 2% rms ripple are the output ratings of this latest high-voltage power supply. For use in dielectric cable testing and particle accelerators, and for study of high-voltage discharges, the power pack is oil-insulated and safe to operate. Selenium rectifiers are used to increase reliability and reduce over-all size and weight. *Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn.*

Telephoned Images . . .

Using standard telephone lines, the Videx system transmits a 400-line image of charts, sketches, maps, and 3-dimensional objects in a scanning period of 60 seconds. The device consists of a slow-scan Vidicon camera for sending and a direct-view storage tube for receiving. The unit substitutes elapsed time for bandwidth, resulting in a picture with no loss of resolution. Completely transistorized and hand portable, the entire system weighs less than 100 pounds. *ITT Laboratories, Fort Wayne, Ind.*

Wide-Screen Film Viewer . . .

This 16mm film viewer features a motorized film drive, a remote operator's control, and data magnification of 20 times on a large screen. The operator can quickly locate data by using a push button to traverse the film in either direction at 120 centimeters per second and can study it in detail by varying the film speed continuously from 1.3 to 0 centimeters per second. Convenient controls are also provided for changing the direction of film travel, varying the light intensity, varying magnification between 19 and 21 times, and maintaining a continuous sharp focus. *The Geotechnical Corp., 3401 Shiloh Rd., Garland, Texas.*

(Continued on page 34A)

KLM
KLM-Royal Dutch Airlines

Electrical Protection *is MODERNIZED* with BUSS fuses in the KLM Royal Dutch Airlines Building, New York City

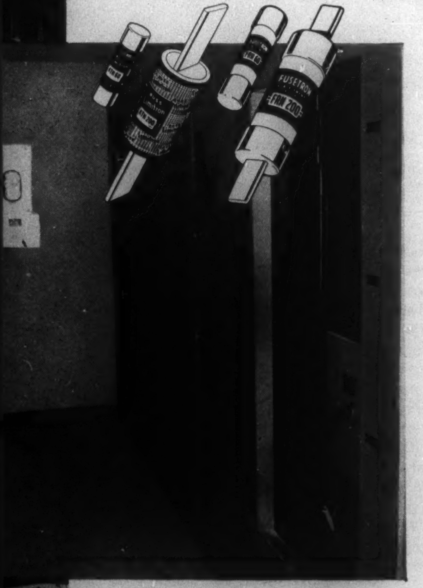
KLM INSTALLATION POINTS OUT THE NEED FOR SAFE INTERRUPTION OF HIGH FAULT CURRENTS

A 3 million dollar modernization program was recently completed on this 13 story office building at 609 Fifth Ave., which houses the American Executive and first floor ticket offices of KLM Royal Dutch Airlines.

To meet power requirements, the capacity of the electrical system was greatly increased, resulting in an estimated available fault current level approaching 100,000 amperes.

In the main switchboard, Buss LIMITRON fuses are installed to provide the high interrupting capacity necessitated by the available fault current and to give great current limitation needed to protect circuits and equipment.

To further assure safe protection and to safeguard against needless outages, distribution and feeder circuits are equipped with FUSETRON dual-element fuses.



Part of Main Switchboard Protected by:
3-3000 amp., 3-1200 amp., 6-1000 amp.,
BUSS LIMITRON FUSES and
15-400 amp., 3-350 amp., 3-275 amp.,
3-250 amp., 9-200 amp., 3-125 amp.,
3-90 amp.,
FUSETRON dual-element FUSES

Fuses Offer the Safest, Most Practical Solution to Modern Protection Requirements

As electrical network capacities increase, available fault currents of 75,000 to 100,000 amps and up are no longer uncommon.

In order to adequately safeguard circuits and equipment, it becomes imperative to install protective devices that can safely interrupt these fault currents.

HIGH INTERRUPTING CAPACITY

Fuses provide high interrupting capacity at a very low cost. Buss LIMITRON fuses have an interrupting rating of 200,000 amps. rms symmetrical — and for FUSETRON dual-element fuses it is 100,000 amps.

CURRENT LIMITATION

Buss LIMITRON fuses also provide current limitation so that fault currents are shut-off before equipment on the circuit can be damaged.

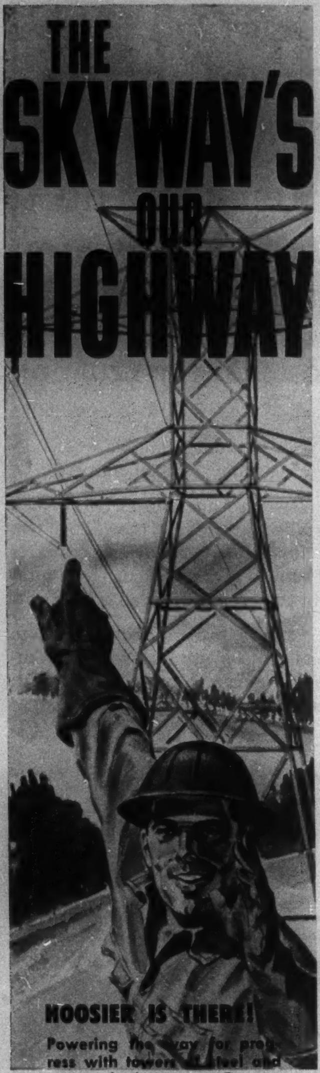
LIFE-TIME DEPENDABILITY

Fuses remain safe and accurate through the years. Fuses have no triggers, latches, pivots or contacts to stick or get out of order. They require no expensive maintenance or recalibration — they are always ready to function the instant trouble occurs.

To help you select the proper fuse, write for the new BUSS booklet . . .
BASIC PROTECTION FOR ELECTRICAL POWER SYSTEMS.

381

BUSSMANN MFG. DIVISION ***McGraw-Edison Co.***
University at Jefferson, St. Louis 7, Mo.



HOOSIER IS THERE!
Powering the way for progress with towers of steel and wires of aluminum. Our 42 years of quality, integrity and service are your guarantee of the finest in transmission and distribution line erection and maintenance. Our complete facilities brochure is available without obligation.

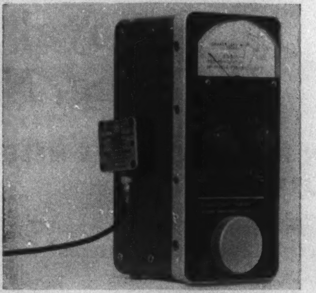
HOOSIER
ENGINEERING CO.
1350 HOLLY AVE • COLUMBUS 8, OHIO

New & Improved Products

(Continued from page 30A)

Vibration Pickup Calibrator . . .

The *1557A* was designed to calibrate accelerometers, pickups, meters, and similar vibro-measurement systems using small crystal-type sensing elements. Providing a standard acceleration of 1g (rms) with ±10% accuracy, at 100 cps with ±1% accuracy, the unit consists of a transistorized electromechanical oscillator and a battery operated cylindrical shaker. Acceleration output appears at two pillbox-shaped 50-gm discs mounted on an internal cylinder with the pickup to be calibrated attached to or replaced by one of these discs. *General Radio Co., West Concord, Mass.*



Code Generator . . .

Codamite was designed to produce perfectly formed Morse characters or coded outputs similar to binary-coded decimal systems. Featuring solid-state digital circuitry, the units allows a selection of transmission speeds from 6 to 42 words per minute. A typewriter key-positioned board of 43 letters, numbers, and punctuation marks directly activates a magnetic core memory in the unit. Practical applications will be found in military reconnaissance or life boat survival, or to provide code signals for manual entry into data-processing and telemetry operations. *Ling Electronics Div., 1515 S. Manchester, Anaheim, Calif.*

Cable-Pipe Layer . . .

A new line of cable-laying attachments for all popular makes of heavy duty crawler tractors will lay telephone or power cable as well as plastic, copper, or aluminum pipe, and conduit, without trenching. A special cable-laying shank mounted on the tool beam of the heavy-duty ripper opens up a cut up to 72 inches in depth and buries the cable or pipe in one continuous operation. Depending on soil conditions, one or two passes with a standard ripper shank are made ahead of the cable-laying pass. Completion rates of 4 miles per day may be achieved where operations are not frequently interrupted by physical obstructions. *American Tractor Equipment Corp., 9131 San Leandro Blvd., Oakland 3, Calif.*

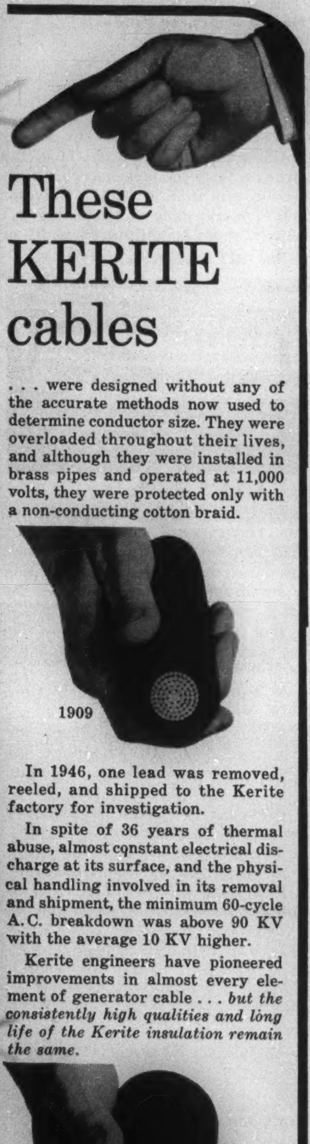
Coil Tester . . .

This new production line product detects short-circuited turns equal to or larger than one turn of no. 25 Awg copper wire. It also measures the number of coil turns with or without ferromagnetic cores with 0.1% accuracy. Direction of winding, symmetry of coils, bifilarity, and resistance of windings may also be performed. The number of turns is determined by comparing the voltages induced by a common flux in the coil to be measured with a reference coil. Unique shielding eliminates all stray flux between the two coils. *Maxim Controls Co., 4734 N. Albina Ave., Portland, Ore.*

Thermoelectric Power . . .

Four sizes are now available for commercial and industrial applications in ratings of 5-, 10-, 50- and 100-watt outputs. These all-static devices are ideally suited to remote locations and should find ready application in cathode protection of pipelines and valve controls, and for powering microwave relays. Gasoline, propane, or natural gas are typical fuels used with operating core temperatures ranging from 300 to 600 C. *Westinghouse Electric Corp., Box 2278, Pittsburgh 30, Pa.*

(Continued on page 40A)



These KERITE cables

. . . were designed without any of the accurate methods now used to determine conductor size. They were overloaded throughout their lives, and although they were installed in brass pipes and operated at 11,000 volts, they were protected only with a non-conducting cotton braid.

1909

In 1946, one lead was removed, reeled, and shipped to the Kerite factory for investigation.

In spite of 36 years of thermal abuse, almost constant electrical discharge at its surface, and the physical handling involved in its removal and shipment, the minimum 60-cycle A.C. breakdown was above 90 KV with the average 10 KV higher.

Kerite engineers have pioneered improvements in almost every element of generator cable . . . *but the consistently high qualities and long life of the Kerite insulation remain the same.*

1960

THE KERITE CO.
30 Church St.
New York 7, N. Y.
Sales offices in principal cities.

Positions Available

(Continued from page 28A)

Basic knowledge of radar circuits, magnetrons and microwave plumbing. Some knowledge of radar antennas also desirable. Company pays fees. New York suburban area. W9992.

ASSISTANT ELECTRICAL ENGINEER, graduate, with industrial or public utility experience in the electrical field, for trade association work. Must be willing to travel. $8000-$10,000. Resident of New York area. W9987.

RESEARCH ENGINEER for work on electromagnetic relays and choppers. Must have thorough knowledge of physical, electrical, and magnetic properties of materials and several years' experience with small electro-magnetic devices. Excellent opportunity with well established company. Open. Connecticut. W9973.

PRODUCT ENGINEER, graduate mechanical, metallurgical or electrical, with two to five years' in engineering, for product engineering in fuel group. Pennsylvania. W9971(a).

DEVELOPMENT ENGINEER, graduate mechanical or electrical, for electronics. Experience in ultra or radio frequency. (Experience in radio receivers and transmitters would be qualified.) $8000. New York City. W9966.

SENIOR PROJECT ENGINEERS, electrical graduates. (a) With five to ten years' experience in circuits such as precision bridges, dividers, potentiometers including methods of compensating for semiconductor resistance used with these circuits. Must be able to design solid state circuits, involving digital techniques. (b) With five to ten years' experience in design of equipment to perform electrical measurements to a high degree of accuracy. Background in potentiometers, standard cells, bridges, ratio sets, null detectors and other similar equipment used in measuring voltage and resistance to a few parts per million. $9000-$15,000. Newark, New Jersey area. W9965.

QUALITY CONTROL ENGINEER, graduate mechanical, electrical or industrial, with three to five years' experience in quality control. Must be familiar with statistical techniques; should be well versed in quality control sampling techniques and procedures used to provide quality engineering assistance to production departments. Will assume #2 technical position in quality control engineering. $8-$9500. Apply by letter and indicate present and expected salary. Agency fees, relocation and interviewing expenses paid by company. Upstate New York. W9961.

CHIEF PLANT ENGINEER, mechanical or electrical graduate, with refrigeration, boiler plant operation, electrical distribution and general building maintenance in food processing plant. $8000-$10,000. Long Island, New York. W9959.

ENGINEERS. (a) Project Design Engineer, Industrial Division, graduate mechanical or electrical, to design, develop and evaluate hydraulic, pneumatic and electrical systems related to commercial control of machine tools. Little actual board work. $10,000-$12,000 and profit sharing. (b) Experimental Engineer, graduate mechanical or electrical, with two to five years' experience in one or more of the following areas: Hydraulic, Pneumatic or electronic design or servo systems work. Background with small intricate mechanical devices most desirable. Experience with servo components, pumps or design of precision instrumentation devices. Background in aircraft or hydraulics company preferred. $8000-$10,000. Apply by letter and indicate present and expected salary. Agency fee, relocation and interviewing expenses paid by company. Upstate New York. W9950.

Chicago Office

UTILITIES AND POWER PLANT ENGINEER, graduate E.E. or M.E. Responsible to plant engineering department for engineering, to make engineering studies on structures, equipment processes and operations to develop plan, estimates and specifications for new installations, alterations, operation and maintenance of utilities and power plant equipment. Assist in direction and coordination of contractors and plant personnel on utilities and power plant projects. Prepare or review specifications for equipment and parts lists for new power plant equipment, analyse suppliers proposals and make recommendations. Assist stress engineers on all items involving utilities or power plant operations, construction manning, etc. Keep current on development equipment and practice in power plant field. Responsible for supervision of contractors to clarify suppliers and contractors to clarify specifications. Experience must have been in process industry with manufacturer of product rather than with consultant or equipment manufacturer. For manufacturer of food products. About $10,000 depending on experience. Chicago. C8487(b).

ADVERTISING ACCOUNT EXECUTIVE, Public Relations, B.S.E.E., Ch.E., M.E., to plan and execute public relations programs for engineering-oriented client firms, including writing general and technical news releases, technical papers, feature articles. Supervise press tours, customer house organs. Maintain active liaison with client management and engineers and with technical magazine editors, for a public relations agency. Employer will pay fee. $7500-$15,000. Chicago. C8480.

SENIOR ELECTRICAL DESIGN ENGINEER, B.S.E.E., supervise junior electrical engineers in electrical engineering assignments and be responsible for compiling fast and accurate technical proposals and complete design of electrical equipment used in hydraulic, pneumatic and electrical ground support equipment. Must know military specifications associated with electrical component and wiring. Power option preferred for a manufacturer of test equipment. $9000-$10,000. Employer will negotiate fee. Chicago. C8469.

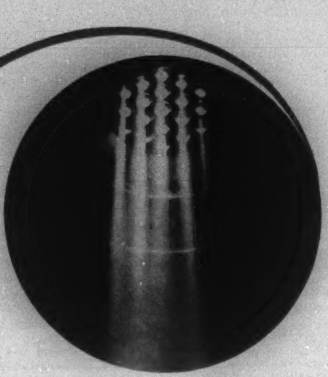
CONSTRUCTION ENGINEER AND AREA ENGINEER, graduate E.E. Design and supervision of construction of transmission and distribution systems. Same for substations. Field trips for extended periods of time for some openings. Prefer single men. Families limited to three children. (Company does no construction, only supervision). Travel for a consulting engineers. $10,000 and up. Asia-Middle East. C8462.

DESIGN AND DEVELOPMENT ENGINEER, graduate E.E.; design and development of fractional horsepower or integral motors and generators. Should be U.S. citizen for a manufacturer. Employer will pay fee. $10,000. Ohio. C8455.

DEVELOPMENT AND DESIGN ENGINEER, M.E. or E.E. Must be interested in automotives for design and development on mechanical timing devices; timed spark ignition. Heading up group in new plant in Alabama for a manufacturer. $9600 depending on experience. Employer will pay fee. C8454.

PROJECT ENGINEER, B.S.E.E., Electronics Major; minimum of eight years' electronic design and development including minimum of three years' of related radar transmitter experience such as design of hard tube modulators, high voltage circuitry, pulsed and CW microwave devices. Duties: Group leader in charge of design and development of high power military radar transmitter. Must be capable of originating new ideas, techniques and over-all system concepts in the multi-megawatt UHF and microwave generation field. Able to analyze complex problems associated with latest state of the art radar transmitter design. Able to evaluate test results and make recommendations. $9600-$11,500. Ohio. C8453.

PLANT MAINTENANCE ENGINEER, graduate M.E., C.E. or E.E. To inaugurate at office level maintenance program for multi-plant operations involving budget maintenance, preventive maintenance programs, etc. for process industry. Will be indoctrinated in company's policy for about two years' in Chicago then assigned to a district as area maintenance supervisor. Must have good personality. Employer will negotiate fee. $9000-$13,000, depending on experience. Chicago. C8356.



Multi-aperture ion engine operating in hard vacuum.

ULTIMA THULE, ION PROPULSION AND BASIC RESEARCH AT EOS*

The ion engine is only one of the devices under development at EOS that is helping to push back frontiers, enabling us to delve deeper into physical phenomena. Being developed under contract, ion rockets will provide practical means of propulsion — helping achieve the *ultimate goals* of space travel.

A basic, inseparable portion of all division activities at EOS, research alone can supply the answers necessary to the completion of our advanced projects. State-of-the-art solutions to specific problems are relatively easy to provide — taking only time and manpower. We prefer to follow the more exacting path illuminated by combining basic and applied research in reaching our objectives — finding that the answers and information uncovered open broad new areas for investigation and opportunity.

*Electro-Optical Systems presently has positions on its Technical Staff for **PHYSICISTS, ELECTRICAL ENGINEERS, MECHANICAL ENGINEERS** who are interested in advanced research and development programs and are experienced in the areas of

Solid State Physics
Materials Research
Fluid Physics
Electronic Systems
Energy Conversion
Advanced Power Systems
Electrochemistry
Quantum Electronics
Re-entry Physics

Scientists and Engineers are invited to contact Mr. Don Smelser at

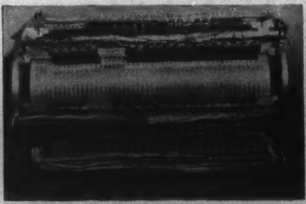
E ELECTRO-OPTICAL SYSTEMS, INC.
O 130 NORTH VINEDO AVENUE
S PASADENA, CALIFORNIA

New & Improved Products

(Continued from page 34A)

Unusual Memory Drum . . .

Particularly adaptable to sorting operations in materials handling, the Dynastat magnetic memory drum operates in synchronism with a conveyor belt or rotary table to accept or reject objects under conditions manually or automatically introduced into the system. Less expensive and less complex than high-density computer-type drums, this device can read-record information at any drum speed, or even when the drum comes to rest. Another advantage is that the read heads have a high power output that eliminates the sensitive amplifiers required with computer-type drums. *Consolidated Controls Corp., Bethel, Conn.*



Pole Switch . . .

This phase-over-phase pole-mounted air switch called Pole-Pak is available in 1-, 2-, or 3-way models in ratings from 7.2 to 69 kv, and continuous ratings from 600 to 1,200 amperes. Consisting of type *57L* braidless air switches, the apparatus is mounted on welded aluminum frames. Unique clamping bands permit proper positioning and suspension without the need for drilled holes, resulting in easier, faster installations. *Southern States Equipment Corp., Hampton, Ga.*

The Condulator . . .

The condulator is a new type of aluminum riser cap designed to allow natural ventilation of the conduit, yet keep out weather. It will also secure any number of cables against slipping back into the conduit. The compound used to fill the top of the cap is a special mixture of polyester resin and glass fibers. All types of sheathed or insulated cables may be accommodated, and the cap will fit any fiber, steel, or plastic riser duct. *Roberts Electrical Products Co., 122 Calaman Rd., Cranston 10, R. I.*

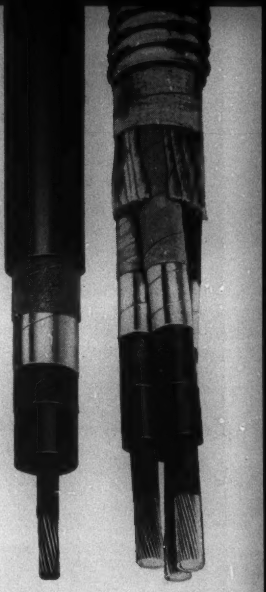
How Circle exceeds the specs to give you…

MAXIMUM DIELECTRIC STRENGTH

EVERY order for power cable calls for certain specifications to be met. At Circle, the point is not how well these specs are met – but rather how far *they are exceeded.*

Example: the well-known "double-voltage" test as required by IPCEA-NEMA. The table below demonstrates *one of the ways* Circlesheath Type RR power cable exceeds specs to give users maximum performance. Circlesheath also excels in ozone resistance, long-term stability and other essential power cable requirements.

Power cable reliability is no haphazard achievement. It requires continuous supervision by men who not only care enough but know enough to produce the very best. Specify Circle on your next job – there's no finer cable made.



CIRCLE WIRE & CABLE CORP.

SUBSIDIARY OF **CERRO CORPORATION**

PLANTS: Maspeth and Hicksville, N. Y. **SALES OFFICES & WAREHOUSES:** In all principal cities.

Rubber Covered Wires & Cables • Varnished Cambric Cables • Plastic Insulated Cables • Neoprene Sheathed Cables • "CIRTUBE" EMT

CABLE SIZE	RATED VOLTAGE	DOUBLE AC TEST VOLTAGE	CIRCLE B'KDN VOLTAGE	MAXIMUM STRESS IN VOLTS PER MIL
2 AWG	5KV	28KV	48.3KV	454
1/0 AWG	5KV	28KV	40.3KV	356
500 MCM	5KV	31KV	44.6KV	307

CIRCLE WIRE
CERRO

Industrial Notes...

Petersen Engineering
Santa Clara, Calif. . .

Petersen Engineering Co. has supplied PENGO model *7000-TR-1-72* bullwheel tensioner, model *6700 BWCP SK-II* bullwheel cabel pullers, and a pair of *6100 TCRW* powered reel winders, for use in tension stringing in General Electric Company's "Project EHV" prototype transmission system. The neoprene-lined PENGO tensioner bullwheels were modified to four grooves of 2½ inches in diameter instead of the usual six 2-inch grooves, in order to handle the 2.32-inch conductor. The puller bullwheel grooves were standard 1.39 inches in diameter which is ample to accomodate pulling lines used. The PENGO tensioner is designed to operate at continuous working tensions to 25,000 pounds. Tension stringing, which keeps the conductor in the air at all times during stringing, is advantageous in ehv stringing because it greatly reduces the chance of conductor damage. Arrows in the accompanying photograph indicate model *7000-TR-1-72* tensioner (lower) and powered reel winder (upper).

Burns and Roe, Inc.
New York, N.Y. . .

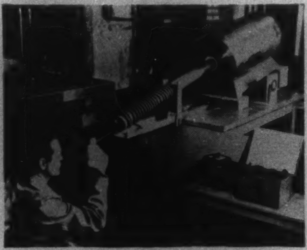
Burns and Roe, Inc. were hosts at a recent luncheon marking the beginning of the firm's second quarter-century as engineers and constructors. Included among the projects in which Burns and Roe played important roles are the BOMARC missile, the NIKE-ZEUS anti-missile missile, and the SAGE electronic computer stations network. The company was also active in the development of an evaluation test unit for the U.S. Navy's TALOS missile. Other Burns and Roe work includes steam power plants, nuclear projects, aeronautical test facilities, missile ground support equipment, industrial and chemical facilities, and electronic facilities.

NEMA
New York, N.Y. . .

Unconventional generation of electric power was the topic of a discussion at a recent meeting of the National Electrical Manufacturers Association (NEMA). Representatives of 22 leading member companies of NEMA attended. It was decided to organize a new Unconventional Power Generation Section within the association. Called the most advanced technical industry group to affiliate with NEMA, the section will be involved with magnethydrodynamics, fuel cells, thermoelectrics, thermionics, batteries, photovoltaics, and photochemicals. Early projects will probably deal with Government contacts and the development of standards for basic terms, definitions, and tests. It is expected that invitations will be extended shortly to companies in this field which are not presently members of NEMA to join the Association and affiliate with the new Section.

Chase Brass & Copper
Waterbury, Conn. . .

Chase Brass & Copper Co., a subsidiary of Kennecott Copper Corp., has devised a new technique for joining copper to copper and certain alloys to copper. Cost savings, easier production methods, and improved products are among the advantages which may result from the new technique. In this process, two or more copper components can be joined together with a homogeneous bond as strong as or stronger than the base metal. A special coating on the metal surface diffuses into the parts to be joined, and under proper conditions produces a bond without an interface. Joints made in this manner are said to retain virtually all of the high electrical and thermal conductivity of copper, making them advantageous for many electrical and electronic applications.



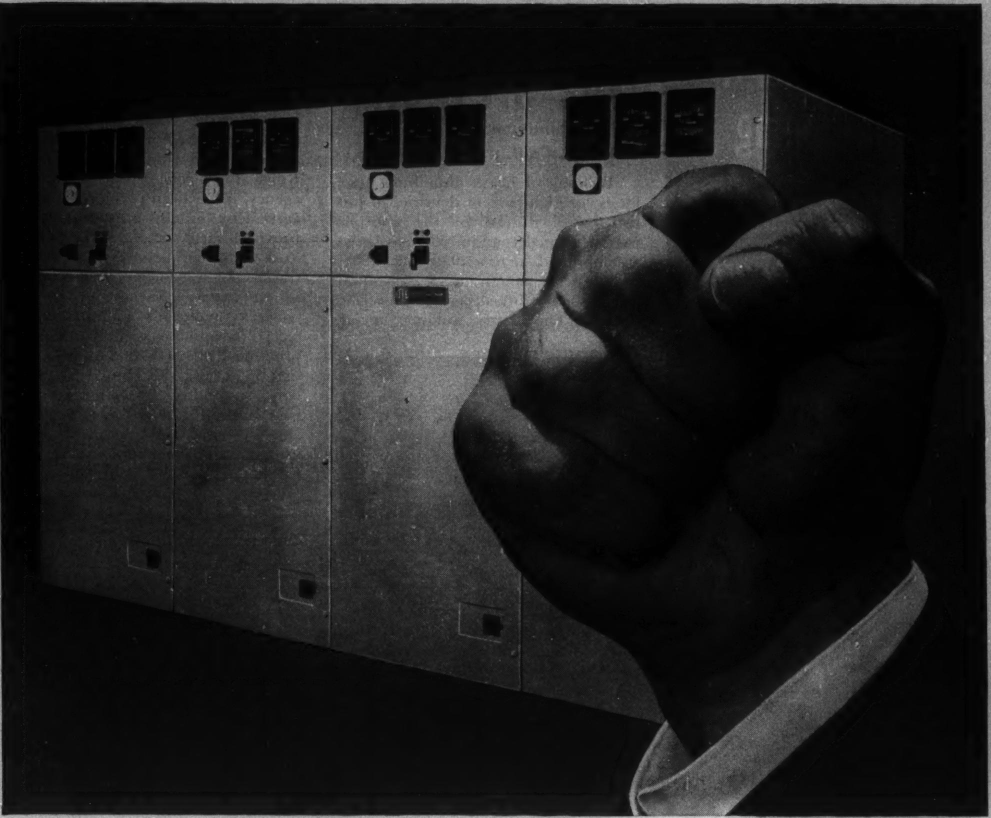
Bell Telephone
New York, N.Y. . .

The American Association for the Advancement of Science (AAAS) has presented its annual "Industrial Science Achievement Award" to Bell Telephone Laboratories, Inc. The award is given to companies which have helped significantly to demonstate one or more of the objectives of the Industrial Science Section of the AAAS. Included in these objectives is the "advancement of knowledge and the practical application of science in industry." The citation to Bell Laboratories was for its achievements in the field of universal communication during the year 1960. Among the advances cited were Bell's long-distance communications from the Echo I satellite, Time Assignment Speech Interpolation system, and the Morris, Ill. electronic telephone switching system. Pictured here is Bell's "telephone terminal to outer space" at Holmdell, N.J.

Rogers Publishing Co.
Denver, Colo. . .

Twenty-three thousand military standards have been added to the Vendor Specs Microfilm File (VSMF) system of Rogers Publishing Company. An information retrieval and product searching system developed by the Technical Services Division, VSMF is now in use in major aerospace plants throughout the United States. Said to reduce product searching time nearly 90%, the system has as its key a newly developed, copyrighted index which permits the user to obtain the desired information no matter how it occurs to him to look it up in the index. In addition to the military standards, MIL-D-70327 (Vital Military Drawings) and Military Handbook 300 ("Ground Support Equipment for Air Weapons Systems") have also been added.

(Continued on page 44A)



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For example, this is the first 13.8 kv switchgear designed exclusively for stored energy closing. That means it closes fast every time. Contacts last longer, and that keeps down the upkeep. I-T-E's unique ratchet and pawl stored energy mechanism eliminates the need for a brake or clutch which would require periodic maintenance.

The breaker is more compact and actually hundreds of pounds lighter in weight than the previous model. So it's easier to move around, has a lower center of gravity. And one man can do all the maintenance work, including raising the arc chutes and maneuvering the frame.

All secondary wiring is in the front—away from the high voltage bus. You can service it without shutting down the board. Access to instruments is through a separate door to an isolated compartment, for still greater safety.

Low-cost maintenance is only one of the economy features of this new I-T-E 13.8 kv switchgear. It saves space—roughly 30 cu. ft. per frame. Stored energy means you can use a smaller battery or transformer for closing. And you can disconnect the breaker without opening the front doors—saving time in routine operations.

If you are about to specify 13.8 kv switchgear, make sure you get all the advantages only this I-T-E equipment offers. See the new illustrated Bulletin 2800-2B. Call your nearby I-T-E sales office. Or write I-T-E Circuit Breaker Company, 1900 Hamilton St., Philadelphia 30, Pa.

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AiResearch Manufacturing Division

Los Angeles 45, California

Industrial Notes

(Continued from page 42A)

Kaiser Aluminum Oakland, Calif. . .

Welding of heavy aluminum plate by use of high current densities in just two passes instead of the multiple passes normally required, has been accomplished in new plate thicknesses by Kaiser Aluminum & Chemical Corporation's Welding Engineering Branch. The 2-pass welding having full penetration and high weld quality in 2-inch *5083* alloy plate, utilizes automatic inert gas-metal arc (MIG) welding equipment. This welding development may extend the thickness range which can be production-welded in two passes using automatic MIG welding equipment with 1/16-inch filler wire from the present 1¼-inch thickness to 2 inches. Under conventional welding practice, up to 12 weld passes are required to weld 2-inch aluminum plate.

Control Data Corp. Minneapolis, Minn. . .

Control Data Corp. is experimentally testing a new microwave data link for high-speed digital data transfers between computers situated miles apart. The new microwave link allows Control Data Satellite Computer Systems to communicate over many miles, limited in distance only by "line-of-sight," although the distance can be extended virtually indefinitely by use of unattended repeater stations. Digitally modulated microwave impulses are currently being transmitted in two directions via a Motorola model *MR 40* 12,000-mc broad-band microwave communication system between a Control Data *1604* computer located at Control Data headquarters in Minneapolis, and a Control Data *160* computer located at Control Corporation, a subsidiary of Control Data. Checked data are being transmitted at a rate in excess of 1.2 million binary digits per second from the magnetic core memory of one computer to the magnetic core memory in the other.

Consultants Bureau New York, N.Y. . .

A contract establishing terms for exclusive English language rights to Soviet scientific books for the next 6 years was signed in Moscow by Consultants Bureau of Mezhdunarodnaya Kniga, the official Soviet Book export agency, it has been divulged. The new agreement contains automatic renewal provisions at 2-year intervals. The New York publisher believes that the contract will result in improved communications between Soviet and American scientists, and that it indicates that the official Soviet book agency anticipates a prolonged period of free trade between the USSR and the United States. All books published by Consultants Bureau in the future will be made available to English-speaking scientists within 6 months of their publication in the USSR.

Aluminum Co. of America East Los Angeles, Calif. . .

Rome Cable Division of Aluminum Company of America has established new electric cable production facilities in a Los Angeles plant. Called the Special Products Facility, the new production unit now in operation has as its task the custom fabrication of cables and cable assemblies to customer specification. The facility provides users of specialized cables and cable assemblies with a source of supply coordinated from raw material through completed assembly.

Autonetics Downey, Calif. . .

U. S. Army artillery battalions are expected to derive improved firing accuracy and battlefield mobility from ABLE (Autonetics Base Line Equipment), a portable, gyroscopic direction finder now in production at Autonetics, a division of North American Aviation, Inc. The Army's $3.5 million contract calls for Autonetics to produce 100 units in addition to providing other services related to the artillery orienter. ABLE is a precision gyrocompass which determines true north to less than 30 seconds of arc standard deviation in less than 20 minutes' operating time. This is accomplished by a high-precision gyro which utilizes the advantages of bias compensation through reversal of the rotor's spin. Operation requires no formal training and but a few minutes of orientation. ABLE is operable in any weather.

(Continued on page 46A)

NATIONAL BUILDS GIANT COILS FOR STANFORD UNIVERSITY'S MAGNETIC SPECTROMETER

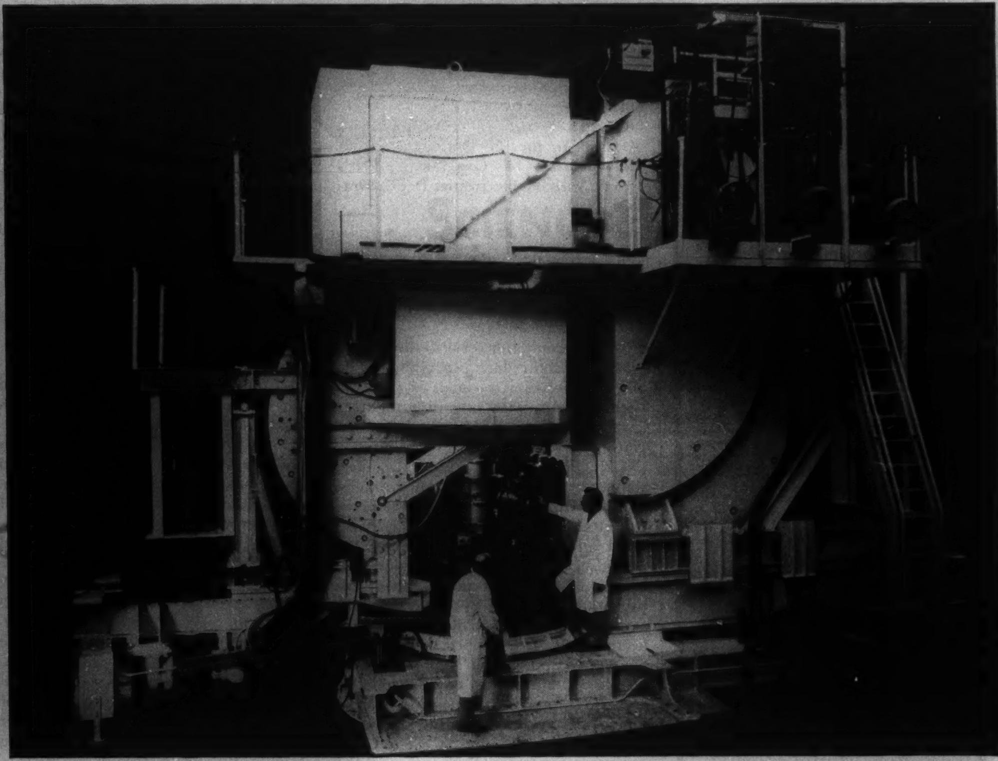
This 72-inch radius spectrometer at Stanford is used for the study of inner structures of atomic particles and particle phenomena.

National built the coils and assembled them into the core of the large semicircular magnet, standing on its point in the right of the photo. The magnet operates at 500-600 volts, 2000 amperes and a field intensity of 18 kilogauss.

A stream of particles is bent 180° around its circumference, slinging heavier particles to the outside by centrifugal force and enabling the number of those of each momentum to be determined.

Working to close tolerances, National built the magnet, using 96 hollow conductors for the main coils, 32 conductors for the auxiliary coils. Hollow conductors permit circulation of the coolant. In the final assembly the insulated conductors were vacuum-impregnated in epoxy resin and cured into a solid mass.

National has unique experience in building electromagnetic components for special requirements. For more information call our Columbus plant...HUdson 8-1151...or the nearest National field engineer.



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Work includes tailoring on designing new instruments for physical and chemical measurements, process control and unit operations involved in fuel cell systems. This is an excellent opportunity for a competent man well versed in the fundamentals of process feedback control and electronic control devices.

Please send a detailed technical résumé to Mr. R. C. Birdsall, Lockheed Missiles and Space Division, Dept. M-20A, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

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Industrial Notes

(Continued from page 44A)

General Electric Schenectady, N. Y. . .

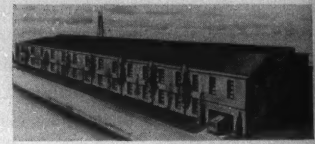
Plastic "windows," through which high-power radar pulses will be directed at giant antenna reflectors for the U. S. Air Force's Ballistic Missile Early Warning Surveillance (BMEWS) radars, are being fabricated from a Textolite glass epoxy laminate by General Electric Corp. The radar "windows," made of a G-10 glass epoxy laminate designated *11546*, are part of the 704 feedhorns which direct multimillion watt bursts of radar energy at the four giant antennas installed at the Thule, Greenland BMEWS site. Subjected to hurricane-like winds and extreme Artic temperatures on the outside, and to continually circulating hot air on the inner surface to prevent icing, the plastic windows must be able to withstand temperature variations of −770 to 50 F, and yet maintain close dimensional stability and not dissipate the energy transmitted by the feedhorns. The plastic windows are being fabricated by Micarta Fabricators, Inc., of Chicago, for the Andrew Corp., a subcontractor to General Electric's Heavy Military Electronics Dept., Syracuse, N. Y.

Nat'l Cash Register Dayton, Ohio . . .

A new computer service, which will make electronic data processing available to companies as small as a neighborhood store with one cash register, has been opened in New York by the National Cash Register Company (NCR). The company plans to offer similar service in major cities throughout the United States. The service is expected to help boost the efficiency of small and medium-size companies by providing them with a more detailed picture of their operations than could previously be obtained. The New York service, located in NCR's Manhattan headquarters is equipped with a new $75,000 computer, the NCR *390*. The service will automatically prepare sales and inventory reports, payrolls, customer bills, and other business records. In 1 hour, the desk-size NCR *390* computer can automatically turn out a detailed analysis of 50,000 retail transactions. In less than an hour, it can figure the earnings and deductions for a company with 250 employees, write their pay checks, and prepare a complete payroll record for each individual.

Eutectic Welding Alloys Flushing, N.Y. . .

Eutectic Welding Alloys Corp. has revealed plans to construct a $2.5 million metallurgical plant and research center (pictured here), to be begun in 1962 at its World Headquarters in Flushing. The announcement was made at a luncheon for civic and industrial leaders marking Eutectic's 20th anniversary. Ceremonies included the welding into place of a metal "cornerstone" for a new administration building now being completed in Flushing, and the introduction of a 20th Anniversary Parade of New Products, including Eutectic's Neu-Tec-Tronic, a highly conductive solder-type alloy, and Eucleen paste for removal of oxide films from the weld area of copper, stainless steel, and other metals. The new metallurgical center, along with a pilot center already being operated in Switzerland by overseas affiliates of Eutectic, will enable the firm to produce electrodes from virgin metal to finished product entirely in its own facilities.



General Dynamics Corp. New York, N.Y. . .

Columbia University has announced the purchase of a self-regulating TRIGA research reactor, the first nuclear reactor to be installed and operated in New York City. Developed by General Dynamic's General Atomic Division, the Columbia TRIGA will be a Mark II above-ground model with a normal operating power of 10 kw (thermal) and will be capable of being "pulsed" for fractions of a second to high peak power levels for studies of radiation effects on materials and other specimens. The TRIGA will be used by the Columbia faculty and graduate students for broad-scope research activities, as well as for the production of radioisotopes and for training, under direction of the Nuclear Engineering Science Committee composed of professors of the School of Engineering and various other departments, such as physics and chemistry. The TRIGA will be purchased from a National Science Foundation grant of $247,000.

(Continued on page 48A)

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  PRODUCTION ENGG.
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  PETROLOGY
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NAVAL ARCHITECTURE
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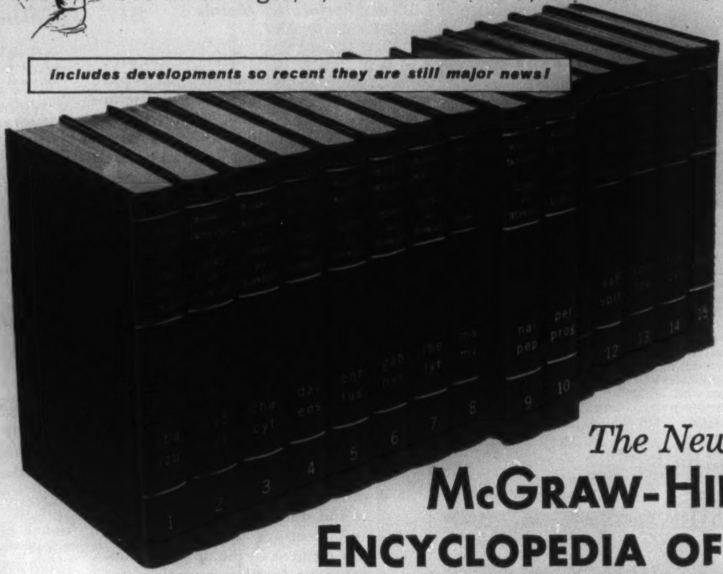

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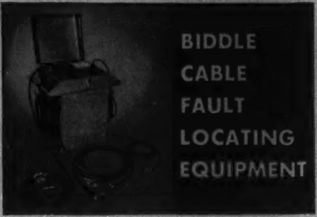

Has applications on aerial, or buried cable, as well as on lead-covered cable installed in ducts. Equipment combines a high-voltage capacitor discharge transmitter with a detector to form a complete Tracer Current Set. Provides high current and voltage output with small energy input. Equipment is moderate in size, weight and cost. Use is not restricted by networks or branches, and under certain conditions will even operate successfully without disconnecting transformers. Method of detection indicates whether fault has been reached or passed when an exploring pick-up coil is applied at various points along the cable.

Biddle Models	Output Voltage	Discharge Capacitance
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All replies giving educational background, complete work experience record including responsibilities and accomplishments, recent photo, minimum salary, and other pertinent details will be acknowledged.

BOX 119

Industrial Notes

(Continued from page 46A)

Cross Perforated Metals Carbondale, Pa. . .

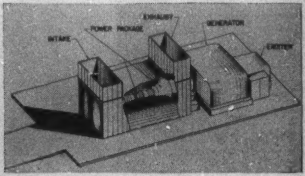
A 424-booth installation of language laboratory equipment has been put into operation during the 1960-61 term in the Wichita, Kans. public school system. The noncombustible language booths, made by The Advance Furnace Company, Wichita, introduce a new type of construction combining ruggedness and durability with new highs in sound absorbing ability and economy. Key element in the new construction technique is splinter-proof perforated metal made by Cross Perforated Metals Plant of National-Standard Company. The 22-gauge perforated metal forms the outer protective surface of "combination-sandwich" acoustic panels that make up the booth. The booths capture 85% of the sound in them.

International Rectifier El Segundo, Calif. . .

International Rectifier Corporation will begin manufacturing selenium rectifiers for industrial and commercial use in India this year under a joint venture agreement with Ram Krishan Kulwant Rai, import-export firm and producer of steel and other industrial products, with headquarters in New Delhi. This is the second subsidiary formed by the company in Asia. Under the agreement, a substantial part of the capital will be furnished by Indian interests in exchange for technical know-how, engineering assistance, and manufacturing equipment from International Rectifier. A new plant to be established in New Delhi under a corporate name not yet announced, will open in June or July of this year largely for the training of Indian technicians and other personnel. Production for industrial and commercial delivery is scheduled to begin in November of this year.

Pratt & Whitney Hartford, Conn. . .

A jet engine-powered electric generator to serve homes and industries will be installed in Hartford by Pratt & Whitney Aircraft division (P&WA), United Aircraft Corp. in conjunction with the Hartford Electric Light Co. (HELCO). A modified J-57 P&WA engine will be harnessed to a generator, providing a fully automated power package which will be housed in a small sound-proofed structure to provide the Hartford area with the additional electric energy needed during "peak load" hours when consumers make extra demands on the power supply. The unit will produce from 8,000 to 10,000 kw. It will be installed on HELCO property and is expected to be operational by mid-1962 as augmentation for the larger steam-operated plants now in use.



Radiation Dynamics Ridgewood, N.J. . .

Radiation Dynamics, Inc. has been awarded a $90,000 contract from Brookhaven National Laboratory, Upton, N. Y., for the construction of the RDI Duo-Dynaply Power Source. Brookhaven is purchasing the Duo Dynaply Power Source for utilization on its Alternating Gradient Synchrotron (AGS). The Brookhaven accelerator has already produced a beam of protons at an energy exceeding 30 billion electron volts (bev), the highest energy ever attained by a particle accelerator. The AGS is being used by Brookhaven scientists to study the fundamental constitution of matter. It is expected that the accelerator will enable American scientists to study nuclear interactions at energies about five times greater than ever before possible. Radiation Dynamics' Dynaply system will be utilized as part of the AGS energy analyzing system.

(Continued on page 50A)

Publications Available from the AIEE

The following publications are sponsored jointly by the American Institute of Electrical Engineers and the other societies mentioned below.

1. **PROCEEDINGS OF THE EASTERN JOINT COMPUTER CONFERENCE** (Computers in Business and Industrial Systems), Nov. 7-9, 1955, Boston, Mass.

   Sponsors: The Association for Computing Machinery, AIEE, The Institute of Radio Engineers.

   100 pages, 15 papers and discussions. Price: $3.00.

2. **PROCEEDINGS OF THE EASTERN JOINT COMPUTER CONFERENCE** (Computers with Deadlines to Meet), Dec. 9-13, 1957, Washington, D.C.

   Sponsors: The Institute of Radio Engineers, The Association for Computing Machinery, AIEE

   259 pages, 48 papers and discussions. Price: $3.00.

3. **PROCEEDINGS OF THE WESTERN JOINT COMPUTER CONFERENCE,** Feb. 26-28, 1957, Los Angeles, Calif.

   Sponsors: The Institute of Radio Engineers, AIEE, The Association for Computing Machinery

   240 pages, 37 papers and discussions. Price: $4.00.

4. **PROCEEDINGS 1957 ELECTRONICS COMPONENTS SYMPOSIUM,** May 1-3, 1957, Chicago, Ill.

   Sponsors: AIEE, The Institute of Radio Engineers, Radio-Electronics-Television Manufacturers Association, West Coast Electronic Manufacturers Association; also Agencies of the U. S. Department of Defense, and the National Bureau of Standards

   282 pages, 43 papers. Price: $5.00.

5. **1958 NATIONAL TELEMETERING CONFERENCE,** June 2-4, 1958, Baltimore, Md

   Sponsors: Institute of Aeronautical Sciences, AIEE, Instrument Society of America, American Rocket Society

   317 pages, 63 papers and abstracts. Price: $4.00.

6. **NONLINEAR MAGNETICS & MAGNETIC AMPLIFIERS PROCEEDINGS,** Aug. 6-8, 1958, Los Angeles, Calif.

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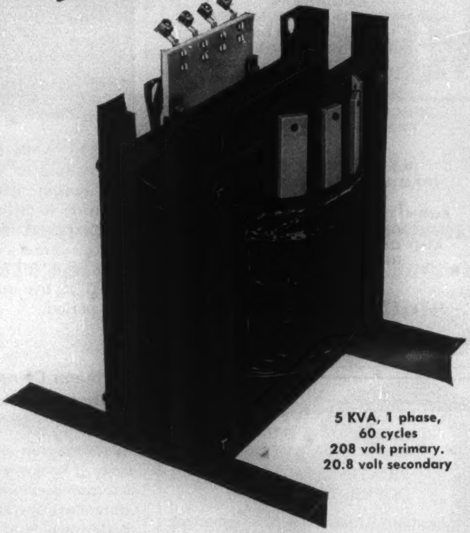

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Send resume including salary requirements to:

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Industrial Notes

(Continued from page 48A)

R. G. LeTourneau, Inc. Longview, Texas . . .

A 4-ton capacity jib crane and electric hoist installed several years ago at Mississippi Power and Light Co. (MP&L) by R. G. LeTourneau, Inc., has resulted in a saving of both time and money, MP&L reports. The installation is utilized in handling poles and heavy electric equipment at MP&L service centers. Additional electric hoists and jib cranes have been installed at five such centers over a 5-year period.

Raytheon Company Lexington, Mass. . .

Raytheon Company officially opened its Lexington headquarters in February. The move consolidated company activities previously carried on in 10 separate facilities at Waltham, Brighton, Watertown, and West Newton, Mass. The new 2-level 137,000-square-foot Executive Office building is located at Raytheon Center, a 100-acre site on Spring St., where the firm expects to erect other office and research facilities at a later date.

Cook Electric Co. Chicago, Ill. . .

The Inland Testing Laboratories, Dayton, Ohio division of Cook Electric Company, is "life testing" batteries for space use. The batteries will be tested until they fail, when "post mortems" will be conducted to find out why the cells have gone bad. It is expected that the test results will be widely distributed and the data developed will give engineers information about battery life and performance that has not been available before. The tests are being conducted under a contract from the Wright Air Development Division, and are expected to continue for more than a year. Initially, Cook Electric engineers will test 160 nickel-cadmium batteries in four insulated chambers kept at 30 degrees below zero, zero, 75 and 120 degrees above zero, temperatures that might prevail in a satellite. In each of the test chambers, the batteries will go through a charging cycle of 55 minutes, corresponding to the time the solar cells might be in sunlight, and then 35 minutes of discharge. A 90 minute "orbit" is fairly typical of low-altitude earth satellites.

Technicon Controls Chauncey, N.Y. . .

Protection of a $5 million boiler and turbine installation from sugar contamination at the Crockett Refinery of California & Hawaiian Sugar Refining Corp., has been undertaken by an analytical instrumentation system called the Technicon AutoAnalyzer. Developed by Technicon Controls, Inc., the industrial model AutoAnalyzer automatically monitors for sucrose traces from 0 to 80 parts per million on stream. Thus, the costly boiler installation is guarded against the damage which would result if appreciable quantities of sugar entered the boiler along with the returned condensate. Readings are graphed automatically on a chart recorder. The "robot chemist" runs continuously without the presence of an attendant.

Allis-Chalmers Mfg. Norwood, Ohio . . .

New Allis-Chalmers sound research facilities are expected to aid in determining the degree, quality, and source of noise for both the motor industry and industry in general. Developed primarily for testing its own products such as motors, generators, and pumps, the facility will be made available to other firms having noise and vibration problems. It will have the capacity to test a-c motors up to 900 hp and d-c motors up to 300 hp.

An airline clerk in San Francisco asks a computer in New York about seat availability on a busy morning flight. Within a matter of seconds he has his answer, based on up-to-the-minute sales and cancellation data from more than a thousand ticket locations across the country. This, in essence, is what the IBM 9090 SABRE System will do when it goes to work for a major airline.

One of the most difficult problems faced by the IBM team that designed SABRE was access speed. At 150 queries a second, the system did not have time to search its disk files for data. The IBM team solved this problem by developing Record Ready—an ingenious method of flagging the needed information ahead of time so that several disks can be spinning to the required locations while one disk is being read.

From the mathematics used to estimate airline traffic to such electronic innovations as Record Ready, SABRE represents a special approach to solving systems problems. It is the kind of approach that takes you to the frontiers of your chosen field and lets you range freely across technical boundaries. In the light of recent IBM achievements in solid state, magnetics and IBM Tele-Processing* Systems, it may hold the key to unusual opportunity for you in systems development. A brochure describing additional engineering opportunities at IBM will be forwarded upon request.

If you have a degree in engineering, mathematics, or one of the sciences—plus experience in your field—write, outlining your qualifications, to:

Manager of Technical Employment
IBM Corporation
Department 550C
590 Madison Avenue
New York 22, N. Y.

IBM

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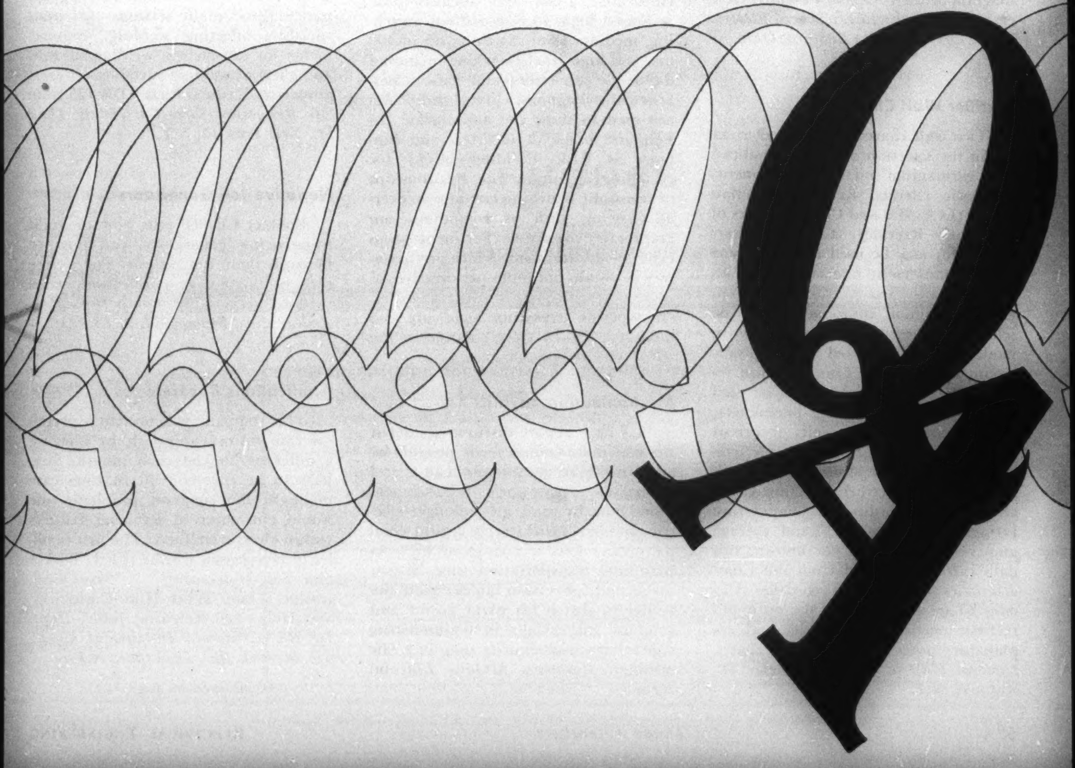
If you plan to be in New York City for the IRE Convention, you are cordially invited to contact the IBM representative at convention headquarters.

When a communications system must reply to 150 questions a second, how can it find time to line up the answers?



Trade Literature . . .

"Welding's Vital Links" . . .

The key role of connections in welding is outlined in this bulletin. Attention to connections will protect the heavy investment in welding equipment and skilled welders, the publication explains. Poor connections not only waste power but also, especially in the newer and more critical processes like tungsten arc and consumable electrode welding, can impair weld quality. Thirteen ways to judge the quality of welding system connections are listed. Electrically and mechanically, each connection should be equivalent to the cable it joins, the bulletin points out. *J. B. Nottingham & Co., 441 Lexington Ave., New York 17, N.Y.*

"One Source Responsibility" . . .

This 4-page 2-color brochure serves as an introduction to the manufacturer's complete line of switchgear, generator and engine controls, substation power controls, industrial control relays, and automatic transfer switches. Eight compact control systems are illustrated and described. Included is a diagram of the company's Unified Generator Control. *Lake Shore Electric Corp., 205 Willis St., Bedford, Ohio.*

Rectifier Wall Charts . . .

Two wall charts can be used to assist in the selection of optimum silicon and germanium rectifier components for basic circuits. Rectifier Selection Chart (ECG-545) and Characteristics of Common Rectifier Circuits Chart (ECG-546) may be used independently or to complement one another. With the aid of the Rectifier Selection Chart, optimum components may be selected rather than more expensive models which are rated above specific circuit applications. This chart will indicate the optimum device to be used based on the following parameters: average amperes per cell, recurrent peak reverse voltage (PRV), and temperature. Three separate charts which make up the Rectifier Selection Chart are set up according to temperature ratings. When the PRV and average amperes per cell are not known, this data can be obtained from the Characteristics of Common Rectifier Circuits Chart to determine the optimum rectifier needed. Color codes and explanatory notes appear in both charts. *General Electric Co., W. Genesee St., Auburn, N.Y.*

Relay-Switch Courses . . .

"AE Industrial Products Training School," a 6-page brochure, outlines the curriculum offered by this company's customer training school. The pamphlet describes the tuition-free courses offered by the subsidiary of General Telephone & Electronics to its customers. The course includes instruction in the maintenance and adjustment of AE relays and switches used in control applications. Course options include "Basic Relays," "Basic Rotary Stepping Switches," and a "Combined Relay/Rotary Stepping Switch Course." The pocket-sized booklet gives enrollment procedures and the 1961 training school schedule. *Director of Sales Training, Automatic Electric Sales Corp., Northlake, Ill.*

Transistor Guide . . .

The "Transistor Guide for Switching Circuit Designers" has been devised to aid engineers in selecting the proper transistors for such applications as saturated DCTL, SCTL, RTL, RCTL, and DTL low-level logic circuits. The guide also discusses nonsaturated logic such as current switching, medium level switching up to 400 ma, and high level switching including d-c to d-c converters, and static relays. Schematic diagrams, curves, and charts are used to show the appropriate design and usage of inverters and flip-flops as basic building blocks for switching circuitry. The relationships of transistor switching circuitry to overall systems, such as computers, are graphically presented. Pertinent properties of the transistor which are necessary to obtain optimum performance of inveter and flip-flop circuits in different types of "transistor logic" are also discussed. *Philco Corp., Lansdale, Pa.*

Mechanization Savings Report . . .

A 4-page report discusses in detail the man-hour savings made possible by mechanizing security, maintenance, and supervisory personnel. The report shows how, by using a 1-passenger electric-powered Truckster, a typical company can effect a savings of 67% in personnel transportation time. Sketch sheets and conversion tables enable the reader to sketch his plant layout and compute his savings in maintenance, supervisory, and security time in a few minutes. *Cushman Motors, Lincoln, Nebr.*

"Variable Inductor Coils" . . .

A 20-page catalog, replete with charts and data, graphically illustrates electrical parameters under various conditions for variable inductor coils. Eliminating the necessity for testing coils under specific conditions, the catalog charts what specific size variable inductor coils will produce under given conditions. The charts may also be employed to predict electrical parameters where certain conditions are met. *Delevan Electronics Corp., 77 Olean Rd., East Aurora, N.Y.*

Foil Welding Article . . .

Reprints of an article by John Campbell, titled "Welding of Foil" are taken from a paper delivered before the American Welding Society convention, which also appeared in the December 1959 issue of the *Welding Journal.* Illustrated with graphs and photographs, the article provides complete information on the control of process variables for the successful welding of foil. Problems and critical variables in the welding of foil by the tungsten-arc process are investigated under three main sections: inherent variables affecting welding; requirements for satisfactory welding of foil; and effect of welding variables on joint properties. Request form ADR-125 from *Air Reduction Sales Co. 150 E. 42nd St., New York 17, N.Y.*

Negative-Ion Generators . . .

Booklet CE 860 tells how to build negative-ion generators, and how to measure their ion output. For a free copy of this 8-page publication, write to the *Westinghouse Lamp Div., MacArthur Ave., Bloomfield, N.J.*

Applications Booklets . . .

This company will present a practical case history approach by offering a different booklet each month. Subjects to be covered will in each case highlight the common problems one would encounter in servicing failures within electric circuitry. The first booklet to be released will be titled "Pocket Size Test Instruments . . . Saves Contractor Time, Wins Him Customers, and Helps Sell Rewiring Jobs." *Dept. DR-RS-3, Pyramid Instrument Corp., 630 Merrick Rd., Lynbrook, N.Y.*

(Continued on page 54A)

An invitation to Engineers and Scientists

The serious minded scientist and engineer who is considering a career change is frequently at a disadvantage because he does not know precisely what positions are available to him. Nor, until now, has he usually been able to find out in a professional, dignified, confidential way.

To meet this professional need the Aerospace Engineering Division of Hughes Aircraft Company announces the inauguration of a new service for scientists and engineers which notifies you whenever an opening occurs which we believe may be of interest to you.

An *Engineering and Scientific Register* has been established wherein you may record your qualifications and interests, even though you are working and not actively seeking a different position. Whenever new opportunities arise, this register is systematically and thoroughly searched.

Hughes is constantly developing new frontiers in science that create needs for specialized knowledge and talent. When these needs arise, we first search the records of present employees; but new developments frequently create a demand for key additions to our scientific and engineering staffs.

Through Hughes' *Engineering and Scientific Register*, we know about you, what you can do and what you would like to do. When a challenging opportunity develops that fits your particular qualifications and desires, we can get in touch with you. You do not make application for employment and no contact is made with present or past employers. You merely permit us to advise you whenever an opening occurs which we believe may be of interest to you. At that time you can decide whether you wish to accept our invitation to be considered as a candidate for the position.

If you would like to be listed in our *Engineering and Scientific Register*, we cordially invite you to fill out and mail the request below.

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AEROSPACE ENGINEERING DIVISION

Administrator, Engineering & Scientific Register
Hughes Aircraft Company
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Please send the form (not an application form) on which to profile my professional background, experience and interests for inclusion in the Hughes' Engineering and Scientific Register.

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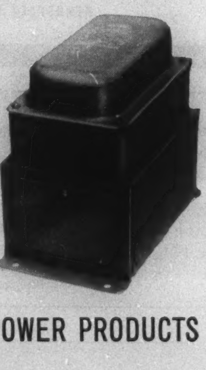

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The widest line—your wisest choice

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Trade Literature

(Continued from page 52A)

Plastics Career Guide . . .

Now available is this 8 page, 2-color brochure "Plastics as an Engineering Career." Included in the brochure are brief descriptions of plastics materials, the plastics industry, role of the plastics engineer, and engineering organization in plastics. The brochure, illustrated by line drawings and graphs, covers the training of a plastics engineer, and describes typical job opportunities after college. In addition, background material and data on the history and development of both polymers and the plastics industry are included. *Society of Plastics Engineers, 65 Prospect St., Stamford, Conn.*

War Gaming Brochure . . .

A new 10-page brochure covers war gaming and military operations research. Called "Trends in Military Operations Research," the booklet covers the development of a soldier-scientist relationship in operations research, the urgent need for data, and war gaming as a partial substitute for field experience. It also points out the increasing need for the synthesis of accumulated knowledge of military operations research. *Technical Operations, Inc., Burlington, Mass.*

Boiler Automation . . .

A definitive, illustrated study of the current status and future of boiler automation is contained in Bulletin G-101, "Automation." The bulletin was originally presented as a paper to the 1960 American Power Conference. *Adv'g Dept., Babcock and Wilcox, 161 E. 42nd St., New York, N.Y.*

Lighting Design Booklet . . .

This 12-page illustrated booklet contains thorough coverage of lighting terms, formulas, and important design factors for easy reference. The photometric CU tables (pendant and surface mounted data plus 10% and 30% floor reflectances) provide a guide to lighting design calculations. Area lighting systems are covered by formulas and CU tables for both panel and louver-type ceilings. On the back page is a listing of current recommended illumination levels for many applications. *Sylvania Electric Products, Inc., One 48th St., Wheeling, W. Va.*

Wavelength Calibrators . . .

Wavelength calibrators for infrared spectrophotometers are now offered at no cost. A polystyrene film in one end of the calibrator may be inserted into the sample compartment of most infrared spectrophotometers. By comparing the spectral curve produced by the film with a polystyrene curve printed on the back of the calibrator, the operator is able to check the instrument for calibration, resolution, and stray light. *Technical Information Dept., Beckman Scientific and Process Instruments Div., Fullerton, Calif.*

Precision Resistance Measurement . . .

Issue no. 3 of "Design Ideas" presents the second part of the previous issue's discussion of 3- and 4-terminal precision resistance measurement techniques. Part II describes in detail the latest techniques and equipment for calibrating a resistor of any value with predictable accuracy relative to a single certified resistance standard. *Electro Scientific Industries, 7524 S. W. Macadam Ave., Portland 19, Ore.*

Welding Wall Charts . . .

These two wall charts show the distinguishing traits of the Oxy-LP Gas flame in comparison with the Oxy-Acetylene flame. Each chart has nine reproductions in full color, with four illustrations referring to the welding flame, and five to the cutting flame. The charts are 11 by 17 inches in size. *Public Relations Dept., Smith Welding Equipment Corp. 2633 S. E. Fourth St., Minneapolis 14, Minn.*

Ferrite Data Sheets . . .

A new series of engineering data sheets on high-power ferrite circulators and broadband, low-power ferrite isolators has been made available. The 2-color data sheets contain the latest information on electrical and mechanical specifications for these microwave ferrite devices. The 21 data sheets include outline drawings with dimensions. *Microwave Associates, Inc., Dept. DB, Burlington, Mass.*

Electrical Insulations Catalog . . .

A 28-page catalog contains suggestions on a variety of flexible composite electrical insulations. The catalog describes the function of electrical insulation and explains the application, properties, and types of the company's line of combinations and constructions. *Milam Electric Mfg. Co., 1100 Elmwood Ave., Providence 7, R.I.*

Materials Handling Ideas . . .

This 80-page booklet is entitled "Handbook of Cost Cutting Materials Handling Ideas." The handbook contains discussions of current materials handling problems. It includes the pros and cons on such subjects as narrow vs. wide aisles, walkies vs. rider-type trucks, specials vs. standard trucks, pallet vs. palletless handling, and selection of the right truck for the job. Also, a thesis on how to analyze materials handling in your plant, flow charts, truck battery calculator charts for selecting the correct battery, and case histories of proven cost-cutting truck applications. *Automatic Transportation Co., 149 W. 87th St., Chicago 20, Ill.*

Metallurgy Miniaturization . . .

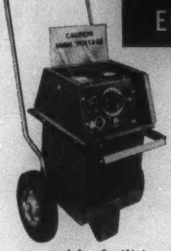
The latest Powder Metallurgy Quarterly features case histories of a variety of small, complex powder metallurgy parts, illustrating the role of this process in miniaturization. The applications described include stainless nozzles used in electric steam irons, a high-density file-hard steel flint guide block for a cigarette lighter, a brass cam follower tip made to ±0.001-inch tolerance, and small stainless bushings that operate at 1,400 F in an automotive heat control assembly. A special feature in this issue is a description of sintered nickel cadmium batteries and their application in powering satellites. News of the industry and a calendar of meetings of local sections of the American Powder Metallurgy Institute are included. *Metal Powder Industries Federation, 60 E. 42nd St., New York 17, N.Y.*

Solder Alloy Bulletin . . .

Technical data bulletin Z-105 describes Alloy *D-800*, a new high-strength low-temperature solder alloy. The alloy is a preform material able to withstand loads at elevated temperatures without serious deformation. At 200 C, the material is 80% harder than normal solder alloys. The bulletin shows that Alloy *D-800* is suitable for semiconductor processing as a lead base *N*-type ohmic junction material, containing neither boron nor free iron. Listed is all data such as specific gravity, specific weight, compressive strength, fatigue strength, and tensile strengths and hardness at various temperatures. *Accurate Specialties Co., Inc., 345 Lodi St., Hackensack, N.J.*

(Continued on page 56A)

DIELECTRIC TEST EQUIPMENT



40 KV Model is a one-man portable set for maintenance d-c tests. Maximum safety built in. Simple operation. Reliable performance. You get excellent output voltage with facilities for voltage and leakage current measurements.

Also available: model for operation up to 100 KV and another for operation to 5 KV. Useful for development work to test d-c dielectric strength of insulating materials and adequacy of design of insulation in equipment; also in production tests for nondestructively detecting defects in electrical insulation.

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B1006

JAMES G. BIDDLE CO.
Electrical and Speed Measuring Equipment
1316 Arch Street, Philadelphia 7, Pa.

MECHANICAL ENGINEER

10 to 12 years experience in mechanical engineering for central station generating plants, good portion of which should have been on design. Detailed knowledge of turbines, boilers, and mechanical auxiliary equipment essential. Prefer man with BSME and 35 to 40 years old.

Will be principal contact man on mechanical engineering problems with design consultants on power plant projects. Should be capable of handling design work on small projects.

Probable starting salary $9000 to $12000. Give complete details of education, work responsibilities and accomplishments, recent photo, and salary expected.

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Laminates • Custom Molding • Extruded Shapes • Channel Stock • Insulators

Trade Literature

(Continued from page 55A)

Ceramic Data Bulletin . . .

Bulletin 121 describes the new HT-1 series of high heat and wear resistant ceramics. Applications are listed, as well as complete data on the three basic types available: Duramic *HT-1-A*, *HT-1-B*, and *HT-1-C*. The data includes information such as specific gravity, softening temperature, hardness, thermal expansion coefficient, tensile strength, compressive strength, dielectric constant, power factor, and thermal conductivity. The bulletin also lists sizes and tolerances available along with fastening methods. *Duramic Products, Inc., 426 Commercial Ave., Palisades Park, N. J.*

Power Supplies Bulletin . . .

A 2-page product information bulletin (Series 701) describes this line of high-voltage power supplies with output voltages of from 40 to 40,000 volts. The bulletin, entitled "Power Packages for Outputs of 40 to 40,000 Volts," describes the use of AMPLI-FILM, the AMP high-voltage dielectric, to insure tight regulation and low ripple voltage. The second page of the bulletin gives complete specifications for a representative group of six of the Capitron Division power units. Specifications for each unit include data on input, output, ripple, regulation, temperature, size, weight, and special features. *AMP Inc., Harrisburg, Pa.*

Reproduction Selector Chart . . .

Applications and specifications for a broad range of diazotype reproduction materials are condensed for easy reference in this dual-purpose selector chart. Printed on heavy stock, the 11- by 17-inch Selector Chart lists all uses, base materials image colors, printing speeds, stocks, trade names, price ranges, sheet and roll sizes, and eradicators. All types of materials are classified broadly by the dry (ammonia) process, and by the semimoist (alkaline and nonalkaline) process. The selector may be used as a wall chart in the reproduction department, or as a file-folder reference aid in engineering, drafting, systems, and purchasing departments. Utility of the chart for personnel not directly concerned with reproduction is increased by inclusion of a simplified description of the basic diazotype positive copy (white-print) process. *Frederick Post Co., 3650 N. Avondale Ave., Chicago 18, Ill.*